MANUAL

OF

MILITARY SURGERY,

FOR THE USE OF

SURGEONS IN THE CONFEDERATE STATES ARMY;

WITH

Explanatory Plates of all Useful Operations.

BY

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Surg Wm C Holbeck
from his friend the
Author

TO

SAMUEL PRESTON MOORE, C. S. A.,

SURGEON-GENERAL OF THE CONFEDERATE STATES ARMY,

IN APPRECIATION OF THE VERY EFFICIENT MANNER IN WHICH HE

HAS ARRANGED AND CONDUCTED THE BEST ORGANIZED OF

ALL THE DEPARTMENTS OF OUR ARMY, THIS

BOOK IS RESPECTFULLY

DEDICATED.

PREFACE TO FIRST EDITION.

In putting forth this Manual of Military Surgery for the use of Surgeons in the Confederate service, I have been led by the desire to mitigate, if possible, the horrors of war, as seen in its most frightful phase in military hospitals. As our entire army is made up of volunteers from every walk of life, so we find the surgical staff of the army composed of physicians without surgical experience. Most of those who now compose the surgical staff were general practitioners, whose country circuit gave them but little surgery, and very seldom presented a gunshot wound. As our country had been enjoying an uninterrupted state of peace, the collecting of large bodies of men, and retaining them in health, or the hygiene of armies, had been a study without an object, and, therefore, without interest. When the war suddenly broke upon us, followed immediately by the blockading of our ports, all communication was cut off with Europe, which was the expected source of our surgical information. As there had been no previous demand for works on military surgery, there were none to be had in the country, and our physicians were compelled to follow the army to the battle without instruction. No work on military surgery could be purchased in the Confederate States. As military surgery, which is one of expediency, differs so much from civil practice, the want of proper information has already made itself seriously felt. In times of war, where invasion threatens, every citizen is expected to do his duty to his state. I saw no better means of showing my willingness to enlist in the cause than by preparing a manual of instruction for the use of the army, which might be the means of saving the lives and preventing the mutilation of many friends and countrymen. The present volume contains the fruit of European experience, as dearly purchased in recent campaigning. Besides embodying the experience of the

masters in military surgery as to the treatment of wounds, I have incorporated chapters upon the food, clothing, and hygiene of troops; with directions how the health of an army is to be preserved, and how an effective strength is to be sustained: also, the duties of military surgeons, both in the camp and in the field. In preparing this volume, I have not hesitated to add to my own experience in the treatment of surgical injuries any useful information which I could obtain from the most recent German, French, and English works on military surgery; and in many instances, where the language used by them expressed to the point the subject under discussion, I have not hesitated to transfer entire sentences directly to these pages. I make this acknowledgment *en masse* of the very liberal use of the following works, as quotation marks were sometimes overlooked:

Maximen der Kriegsheilkunst, von L. Stromyer, Hanover, 1855; Supplement der Maximen der Kriegsheilkunst, von L. Stromyer, Hanover, 1860; Loeffler Behandlung der Schusswunde, Berlin, 1859; Histoire Médico-Chirurgicale de la Guerre de Crimée, par le Docteur Adolphe Armand, Paris, 1858; La Guerre de Crimée, par L. Baudens, Paris, 1858; Des Plaies d'Armes a feu; Communications— Faites a l'Académie Nationale de Médicine, Paris, 1849; Notes of the Wounded, from the Mutiny in India, by George Williamson, London, 1859; Coles' Military Surgery, with Experience of Field Practice in India, London, 1852; Gunshot Wounds of the Chest, by Patrick Fraser, M.D., London, 1859; Guthrie's Commentaries on Military Surgery, London, 1855; McLeod's Notes on the Surgery of the Crimean War, London, 1858; Hennen's Principles of Military Surgery; Larrey's Military Surgery; Ballingall's Outlines of Military Surgery; Gross' System of Surgery; Erichsen's Science and Art of Surgery; Jackson on the Formation, Discipline, and Economy of Armies; Sédilot, Medicine Operatoire, Paris, 1853; A Practical Treatise on Military Surgery, by F. H. Hamilton, M.D., New York, 1861; Report Medical Department (Army) ordered by the House of Commons to be printed, July 3, 1856; Gavin on Feigned Diseases, London, 1843.

August, 1861.

PREFACE TO THE THIRD EDITION.

After three years of incessant and bloody warfare I have been called upon to embody, in a new edition of "The Manual of Military Surgery," the large experience of the medical staff of our army. It has been my aim to condense, in a concise, practical form, the improvements in the treatment of gunshot wounds which have been developed during our active campaigns, and repeatedly confirmed upon thousands of wounded. In collecting this experience, I am under heavy obligation to my friend, Surgeon H. Baer, P. A. C. S., who was kindly permitted by Surgeon F. Sorrel, C. S. A., the accomplished and efficient Inspector-General of Hospitals, to collate for me condensed tabulated reports of all the papers in his office, comprising the official reports of all the hospital and field surgeons of the Confederate army. Only those who have undertaken to tabulate statistics can appreciate the labor of Surgeon Baer. Through his assiduity we have an opportunity of contrasting our surgical experience with that of European armies. An examination of these tables will show to what proficiency surgery has attained in the Confederate States.

June 10, 1864. J. J. CHISOLM.

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CHAPTER I.

SUSCEPTIBILITIES OF SOLDIERS — MATERIAL OF ARMIES — RECRUITS — CONSCRIPTS — CLOTHING — CLEANLINESS — FOOD — MARCHING — ENCAMPMENTS — AMUSEMENTS, ETC.

As the strength of an army depends more upon the health and physical development of the soldier than in mere numbers, the hygiene of camps, and the susceptibility of soldiers to disease, has long been a worthy study for military leaders. When men are taken from civil life, where they are accustomed to think and act for themselves, and are gathered together as soldiers, the very act of acknowledgment, or mustering in, deprives them of all liberty, and makes them dependent upon their superior officers. They must now live after a formula — with its drills, labors, fatigues, privations, exposures, guard duties, night-watchings, long marches, and rigid discipline. This new life, which is so different from their former habits, establishes a new era, similar to acclimation, and which is as marked in its effects upon the constitution of the soldier.

Like acclimation, this sudden change from civil to military life constitutes a physiological and moral crisis, which is evinced in an increased mortality, as an initiation, for the first year over succeeding years of service.

The physical and organic revolution which this change engenders establishes a special pathology for soldiers, which differs, in many respects, from the

manding officers. Among volunteer troops, where the regulations of a regular army can not at once be enforced, it should be the duty of the officer in command to appeal to the good sense of the soldier through the orders of the day, and gradually to instil such wholesome rules of hygiene as will make them individually careful for the general good. The sick list will offer a fair criterion of the military *status* of an officer, and his capacity for taking care of his men, which is one of the first rules in military science.

Recruits.—In times of peace an army is formed of recruits, who are enlisted with much care. Each individual, before he is received, undergoes a critical examination by the recruiting medical officer, who rejects all blemishes, as well as those conditions showing a predisposition to disease; the object gained being the selection of a body of men who, from physical and vital perfection of organization, will best resist external morbid influences.

Conscripts and Volunteers.—In times of war, especially between contiguous countries, where national animosity rages high, entire communities rush to arms, and with one accord adopt camp life, with its exposures and trials. This is very conspicuously shown in the present struggle for the independence of the Confederate States, where the army absorbs the entire male population, except such as are physically unable to be useful in any arm of the service. Under the conscript laws which the Confederate States have adopted, the instructions to enrolling officers are rather to prevent those within the prescribed ages from escaping duty, than to select men for their physical perfection of organization. Every able-bodied

man, between the ages of eighteen and forty-five, is not only enrolled, but actually put into the field. These form the movable army of the republic. Beside these, each state has called out, to assist in the local defence, all such as are capable of bearing arms, between the ages of sixteen and eighteen, and from forty-five to sixty. Such, however, is the determination of our people to establish their independence, and to free themselves from oppression, that these prescribed ages do not limit enlistment; but without these limits, wherever there is health, to enter the army seems to be the predominant passion — so that many states of the Confederacy present the singular fact, and apparent anomaly, of having in the field a much larger number of men than are represented by their entire voting population. Entire districts have thus given up their healthy male population — the only representatives being old decrepid men, or invalid, maimed, and broken-down soldiers.

Among those who take up arms in defence of their rights, or for the protection of their homes and families, are necessarily found men from every position in life — from those enjoying the most refined and cultivated social privileges, to the street laborer — all having a common cause to support; men of every variety of constitution, temperament, and idiosyncrasy, in whom every form of disease is found lurking, and ready to show itself upon the slightest provocation. Those who have led lives of ease and luxury are suddenly called upon to assist in the stern and laborious duties of the soldier, to share in the common toil, and to buffet with the elements. The irregular mode of living, and other hardships which they daily undergo, to which the majority are totally unaccustomed, are more injurious than the ex-

posures to which they submit, and to the sanitary influence of which they owe, unwittingly, much of the health which soldiers enjoy. Exercise in the open air counteracts many of the would-be injurious effects of exposure; and soldiers, who have lived for months without tents, sleeping under the protection of trees, exposed to the dews and rains, find themselves suffering from colds and catarrhal affections only when they are permitted, under furlough, to enjoy a long wished-for visit to their families, with the now doubtful comfort of a close room and soft bed. The physical improvement is surprising, which the gloved members of high life exhibit, after even a few weeks campaign, although followed under the most disadvantageous circumstances of inclement weather.

This was well shown among the troops protecting the batteries in the neighborhood of Charleston harbor, prior to the taking of Fort Sumter. When the call to arms was made, the militia—composed, in a large measure, of clerks, merchants, and professional men, most of whom were much more familiar with the duties of the desk than manual labor—with one common impulse rushed to meet the enemy. Many of them, of delicate frames, and frail constitutions, exposed themselves upon sandy islands, directly upon the sea-beach, with little or no protection. They were badly housed, irregularly fed, and miserably watered. Their daily duties were, with pick and shovel, to throw up redoubts, establish batteries, and mount heavy ordnance, during the day; while their nights, when not spent in anxiously watching for an expected invasion, or performing tedious guard duty during a very long spell of stormy wintry weather, were forgotten in sweet oblivion upon the wet sand,

at times without the shelter of a tent. Notwithstanding such exposure, the sanitary condition of the troops was excellent; and many, of delicate frame, returned to their homes, at the expiration of two months, sturdy, robust men, with an addition, in some cases, of twenty-five pounds weight. All, without exception, were improved by the change of life, under the exhilarating influence of sea air and active exercise.

It has been often noticed that soldiers, taken from the better classes of citizens, go through campaigns of great exposure, with many privations, much better than the heavily-built yeomanry. This can be accounted for in the personal care of the one, and the known carelessness of the other. For the same reason, officers are comparatively exempt from those diseases which ordinarily fill the hospitals with sick from the ranks. The immunity from infantile diseases which the adult inhabitants of cities possess, on account of attacks during childhood, is one of the most noted reasons why city troops suffer less in a campaign than soldiers from the country.

All armies confirm the well-established fact that raw recruits, in the field, always suffer more than veterans. In the Crimea, thousands of recruits filled the hospitals *en route*, before arriving at the seat of war. These troops had been collected, indiscriminately, under a pressure. Many of them were young, ill-conditioned, undeveloped in body, unconfirmed in constitution, and hence without stamina or powers of endurance. When compelled to undergo the hardships of a siege, where the strength of full-grown men soon failed, they were very quickly used up. Unaccustomed to either the work, food, or exposure to which they were compelled to submit, they were

readily affected by diseases — and, when severely attacked, they usually died; or, if they survived, their convalescence was painfully prolonged, and the least imprudence produced a relapse. Napoleon, in making a demand for troops, asked for men, as he well knew that boys only encumbered the hospitals and roadsides.

An English Crimean surgeon, in speaking of the character of the troops sent to the East, and of the hardships to which they submitted, mentioned to me that premature old age, decrepitude, with feeble, bent frames, wrinkled faces, and grizzly locks, were seen in youths of two or three and twenty — the effect of two winters' toil, want, and misery.

Our own experience does not corroborate that of European armies. The spirit and chivalry of our youth—the result of their education and mode of living—induced large numbers between the ages of fourteen and eighteen to enter the army. These have shared the toils, fatigues, and privations of our troops, in one of the most active series of campaigns in the experience of modern warfare. So far from encumbering the hospitals, they now comprise our most robust and best soldiers, capable of undergoing great fatigue and privations, and equal to any emergency.

In examining the statistics of the Mexican war, we find the well-established rule, that volunteers suffer more than regulars, confirmed, although the material of which the volunteer force was composed was much superior to the average of armies from conscriptions or forced enlistments. The troops sent out from the states were picked men, well-developed in bodily frame and constitution; yet we find a fearful disparity, when we compare the mortuary reports of the three different arms of the service.

The three classes of troops in the war with Mexico were: the old or standing army, composed of men accustomed to the fatigues and routine of a soldier's life; ten regiments of enlisted men, carefully selected by recruiting surgeons; and 73,000 volunteers, taken at random from all walks of life.* The total loss in the old army, by deaths, discharges, resignations, and desertions, exclusive of discharges by expiration of service, was 7,933 in an aggregate force of 15,736—being 50.79 per cent. for the whole service of twenty-six months, or a monthly loss of 1.95 per cent. In the ten new regiments, using the same basis, the total loss was 3,839 in an aggregate strength of 11,186—being 34.22 per cent. for the whole service of fifteen months, or a monthly loss of 2.28 per cent. In the regiments and corps of volunteers the total loss was 20,385 in an aggregate force of 73,260—being 27.82 per cent. for the average period of service of ten months, or a monthly loss of 2.78 per cent. When it is remembered that the old army stood the brunt of all the early engagements, and that many of the volunteer regiments were never in battle, the dangers of camp life to volunteers and raw recruits become more conspicuously evident. The old army sustained a loss of 5.03 per cent. from killed in battle or dying from wounds—a loss of 792 men from 15,736. The ten new regiments met with a loss of 143 from 11,186, or 1.27 per cent. The volunteer corps, numbering 73,260, lost in battle and from wounds only 613, or 0.83 per cent.; while the actual sick list, carefully compiled, and leaving out all losses to the army except from sickness, amount to 15,617, or 26.83 per cent.

*Medical Statistics U. S. Army, 1839 to 1854.

These statistics, collected with great care by the late surgeon-general of the United States, portray, in vivid colors, the effect of the exposures and hardships of an active campaign upon those who, for the first time, adopt the life of a soldier.

Our very extended experience in this war for Confederate Independence confirms the established rule that it takes time to make a soldier, and that it requires at least twelve months for a recruit to exhaust the list of initiatory diseases, and inure himself to the privations, exposures, and labors of veterans of the Confederate army. This preparation does not show itself to so great an extent when the army is stationary, but tells, without fail, under forced marches and hard fighting, with little food, and as little rest. The first year of the campaign the hospitals were filled with the sick, and but the skeletons of large regiments represented the efficient strength on field-days. Now the sick-roll is wonderfully small, and by far the majority of the army vigorously robust. The liability to sickness is, however, strikingly shown among the conscripts which are being continually assigned to old regiments to fill up vacancies. No reliance can be placed upon such until the initiatory acclimation of several months, on sick-roll and in hospital, has been passed. Even then, when, to all appearances, they go through the routine of camp duty with the ease of veterans, a march at once exhibits their incapacity for the serious work of a soldier.

As not only the valuable lives of citizen-soldiery, forming, morally, socially, and pecuniarily, our very best people, should be to the utmost protected, but also, from the enormous expense and trouble incurred by a nation in training and in transporting an army for distant service, it is imperative that the medical staff

labor to disseminate among the troops those rules of hygiene, which, when considered in its widest sense, are so profitable in sustaining an effective military strength.

We have just seen that, in our own wars, as in all that have ever occurred, an army is *rarely* decimated by the fire of an enemy. Those killed in battle are but a handful, when compared to the victims of disease. In Mexico, our army of 100,182 men, in an average campaign of seventeen months, exposed to the continued fire of an enemy who contested every inch of ground from the seaboard to their capital, making a firm stand at every strategic point, from which they had to be driven under a murderous fire, lost but 1,549 men in battle and from wounds, all told; while 10,986 died in Mexico from disease, besides the hundreds — I would be well within bounds should I say thousands — who returned home to die among their friends from the effects of diseases contracted in camp. For some time after the war, volunteers formed a noted proportion of the inmates of civil hospitals, and the chronic diseases under which they were laboring were with great difficulty controlled.

In the Crimean service, the statistics collected by Lord Panmure, Minister of War, show the English loss to have been 22,457—of which number 3,448 were killed in battle, or died from the effects of wounds received. The French loss, as reported to his government by M. Scribe, Inspector-General of the French medical service in the Crimea, exhibits the frightful loss by death of 63,000, while the admissions into hospital numbered 114,668.

The report from the Surgeon-General of the United States, in giving a medical history of their colossal

armies for the year ending June 30, 1862, gives a general mortality of 67 per thousand—of which 50 per thousand died of disease, and 17 per thousand from wounds and injuries.

The statistics of our armies would be found equally striking with those already mentioned. Our list of killed and wounded, although very large, by no means equals our mortuary list from diseases.

As the beginning of the war found us without an organization, and a very large number of surgeons taken from civil practice, who required a long and tedious education before they were prepared to make useful and carefully-collected reports, no complete statistical tables, showing the proportionate losses by wounds and diseases in our armies, have been as yet compiled. A bureau for collecting and collating the reports of all medical officers has recently been organized, and, under the active supervision of Surgeon F. Sorrel, with an efficient staff, we may soon look for valuable contributions to medical science. A reference to the reports of Confederate military hospitals will, however, uphold the constantly-corroborated fact, that the missiles hurled by an enemy bountifully supplied with all the improved and perfected implements of modern warfare, are comparatively innocent when contrasted with the ravages of disease.

Surgeon McCaw, in charge of Chimborazo Hospital, at Richmond, in compiling his report from November 1, 1861, to November 1, 1863, gives 47,176 admissions into his hospital, of which number 6,740 were from gunshot wounds. There were 3,031 deaths, of which 377 were from the effects of wounds. From the convenient position of Richmond, with railroad communications to the many battle-fields of Virginia,

and the ready transportation for wounded men, this report may be considered a fair proportion of the sick and wounded in our armies—which would show at least ten dying from disease for every one dying from the effects of wounds.

The above statistics are sufficient to show that the efficiency of an army does not consist in its great numbers, but in the sanitary condition of the troops.

The duties of the medical staff are paramount—as the nation should look to them, as much as to the military leaders, for the successful termination of a campaign. Let us now see how this health, which is so valuable to an army, can be preserved.

Recruiting Service.—The first protection which an army has is in the recruiting service, which is a thorough sifting of applicants for admission. The duty of deciding on the efficiency of a recruit depends upon an examination made by a recruiting officer and a military surgeon. The service demands that this examination be thorough, both in regard to moral and physical disabilities. The regulations, therefore, enjoin that—"In passing a recruit, the medical officer is to examine him stripped, to see that he has the free use of all his limbs; that his chest is ample; that his hearing, vision, and speech is perfect; that he has no tumors, ulcerated, or extensively-cicatrized legs; no rupture, or chronic cutaneous affection; that he has not received any contusion or wound of the head that may impair his faculties; that he is not a drunkard, is not subject to convulsions, and has no infectious or other disorder that may unfit him for military service." The surgeon is also required to certify, on honor, that the recruit passed by him "Is free from all bodily defects

and mental infirmity, which would in any way disqualify him from performing the duties of a soldier;" and should it appear that the recruit was, at the time passed, physically unfit to perform all the duties for which he was mustered into the service, the surgeon who recommended his acceptance becomes pecuniarily liable for the pay of the soldier during the time which he has been attached to the army. As the recruit must be between the age of eighteen and thirty-five years, at least five feet four inches in height,* and able-bodied, we can understand why an army, selected by a rigid observance of the above regulations, composed of healthy, robust men, in the vigor of manhood, when brought under thorough discipline, is in the best condition to preserve a high standard of health.

To show with what stringency the laws on this subject are usually observed, we give the recruiting list of the United States Army for 1852. The total number examined were 16,064—of these 13,338 were rejected; 2,276 were alone received into the service. Among the causes of rejection are found the following: Not robust, too slender, unsound, broken-down constitutions, general unfitness, imbecility, unsound mind, epilepsy, intemperance and bad habits, hernia and lax abdominal rings, varicose veins and varicocele, hemorrhoids, syphilis, gonorrhœa, loss of teeth, unequal length of limbs, general and local malformation, contracted chest, spinal curvature, old injuries, fractures, etc.; cicatrices, tumors; diseases of bones, joints, skin, heart, testis, and tunica vaginalis; also of arms, eyes, ears, glands, chest, throat,

* The height of recruits required in the French army, is five feet one inch; in the United States army, five feet four and a half inches; in the English service, five feet five and a half inches.

and abdomen; defective hearing, speech, and vision; ulcers, goitre, ascites and anasarca, obesity, etc.

When we take into consideration the little disparity of age with the absence of so many predisposing causes of disease, we can readily see why the soldier by profession has so great an advantage over the volunteer force, into which any one desirous of performing duty is received, however unfitted he may be, physically, for the toil and privations of camp life.

Under the General Conscript act, now enforced in the Confederacy, the instructions to the enrolling officer are to allow no one capable of performing any duty to escape, rather than select men for their physical perfection. The result is that many, totally unfit for military duty, are forced into the ranks, from which they are soon transferred to the hospitals, where they remain a useless expense to the government—increasing the number without adding to the strength of our forces. In the meantime, the country loses their labor in the agricultural or mechanical occupations to which they had been accustomed, and in the pursuit of which they would have been really useful. Where an entire male population is conscribed and enrolled for active service in the field, it increases greatly the expenses without adding to the effective strength of the army. The same precautions, with critical examination into the physical condition of conscripts, should be made as ordered in the enlistment of soldiers; and such as surgical experience foresees will be the constant inmates of military hospitals, should be permitted to aid the government in a civil capacity, by preparing those articles of prime necessity upon which an army can be alone supported.

To obtain the utmost capacity of labor from men, they must be properly clothed and well fed.—These are the prerequisites, without which their powers of resistance to exposure and excessive exertion are not developed. A soldier is compelled to familiarize himself with many occurrences which experience in actual war shows to be common. He is often called upon for laborious work, to expose himself to wind and rain, heat and cold, to suffer hunger and fatigue, to travel at night as well as during the day, to sleep dressed and accoutred in cloak or blanket. He must be taught, when thus exposed, to secure his person from disease, and to ward off injurious consequences. In short, he ought to be put in possession of the best remedies for every contingency which may possibly happen in military service. This is particularly the case with an armed body which may be called upon at any moment to exert great efforts in making forced marches, and, under many privations, to meet a bold and determined enemy, and to repulse a superior force. *The strength of an army is calculated rather by the physique of its men than by numbers, as experience shows that, other things being equal, men who have been well taken care of are capable of opposing successfully double the force badly provided.*

To preserve health and efficiency, troops must be well clothed.—This is one of the weighty questions in the economy of an army, and has been the subject of much study and experiment by military leaders.

*The object of clothing is to protect the skin from

*Levy on Hygiene, 1858. Jackson on the Formation, Discipline, and Economy of Armies.

diurnal variations or annual perturbations of the atmosphere, while it absorbs excretions, and thus becomes the means which allows man to enlarge his native sphere, and successfully resist extremes of temperature in the torrid or frigid zones. The caloric properties of clothing must be considered under the triple relation of absorption, reflection, and conduction. Every body, whatever be its temperature, is continually throwing off heat from every portion of its surface, the amount of radiation depending upon its temperature and extent of surface. The human body, having a superior temperature to that of the surrounding atmosphere, reflects heat to such a degree as would be incompatible with life, were it not controlled, to a great extent, by the non-conduction of living tissue, and the protective influence of clothing. The first retards the transmission of heat from the centre of the body, while the second acts as a screen.

If two bodies, unequally heated, be placed in proximity to each other, there exists a tendency to produce an equilibrium of temperature. A third body interposed would intercept entirely the heat until it be also heated, so that it may emit from the side corresponding to the cold body that which it absorbs from the warm body. Clothing, placed between man and the atmosphere, exercises this protective influence in proportion to its power of reflection and conduction; and as clothing is a bad conductor of heat, the outer surface of the dress seldom acquires the temperature of the person which it covers. The incarceration of a layer of air between the person and the clothing, and also that which enters into the meshes of the cloth, still further retards the transmission of caloric—heat passing to and through the clothing very slowly, and the layer of incarcerated air being a very poor

conductor. On a quiet, cold day, when we are surrounded by a little atmosphere of our own warming, we feel much more comfortable than when this non-conducting layer is constantly displaced, as on a windy day, when, although the thermometer indicates a much higher temperature, the cold is severely felt.

It is the action of these causes which explains why the exterior of the clothing of a soldier, bivouacked without shelter under the clear sky, is colder than the surrounding air. As bad conductors, the heat which escapes from the skin traverses slowly the thickness of clothing; but, as soon as it reaches the external surface, it is radiated or emitted rapidly. The protection of a tent, or even a cloak, counteracts this radiation. The inverse protection which the blanket gives the Spaniard or Arab in hot weather, is similarly accounted for. The radiating properties of wool exceed its conducting or absorbing powers, and throw off the great heat of the sun before it can penetrate the thickness of clothing and reach the wearer's skin.

Besides the property just enumerated, the hygrometric powers of different fabrics, condensing moisture from the air and absorbing perspiration, are of much importance in the sanitary economy of clothing. In either case, their power of conducting heat is increased; and, therefore, the more moisture they contain in their meshes, the colder they are as apparel. The fluid which the cloth imbibes takes the place of air, and becomes a cause of refrigeration by evaporation, robbing the neighboring skin of its heat to form aqueous vapor. Linen, for instance, imbibes at once moisture from any source, and chills the body by the evaporation of this moisture; this

material for articles of clothing exposes the body to sensations of cold and dampness, and necessarily to the diseases which are brought on by such exposure. Cotton fabrics, although not so attractive to moisture, permit absorption and evaporation to a considerable extent; while woollen goods condense moisture as badly as they conduct heat; from them evaporation goes on so very gradually as scarcely to chill the external surface of the clothing.

The hygrometric properties of clothing are intimately connected with their action upon the skin, when considered as an organ of absorption and excretion. Cutaneous perspiration varies in quantity, according to the powers of conduction, radiation, and heat-absorbing properties of clothing, which can not modify the exhalation, absorption, and sensibility of the skin, without reacting upon its functions. The energy of cutaneous elimination regulates, in a measure, the march of other excretions. Anything which impresses the nerves of the skin excites equally the origin of these nerves, and causes exaltation or depression of the system. Clothing determines the antagonism which exists between animal heat and external temperature. The source of animal heat increases or diminishes its activity according to changes in the atmosphere; but the unequal production of heat causes corresponding oscillations, in the movements of respiration and circulation, in the action of the muscles, and the brain. Clothing affects, then, all the functions of the economy, and may clearly represent the question of health.

As the object of clothing is usefulness and convenience, the best uniform is that which will protect the body from the inclemencies of the weather, and which

least impedes the movements which are connected with military duties. Experience in the field teaches what can be dispensed with, or what can be added with advantage. The clothing selected depends much upon the habits of a people, and the country in which the war is carried on. We can readily understand how absurd it would be in the English government sending their home troops, in their thick red coats, leathered necks, and shakoed heads, to do field duty on the scorching plains of India. There are certain portions of the clothing which experience shows are conducive to health, in all countries, and under every circumstance.

The clothing for troops should be made of wool, whether the material be heavy or light, to suit the climate.

This rule should be particularly observed in the Confederate service, where, during an active campaign, the army being constantly in motion, the large portion of our troops bivouac for weeks, or even months, having no other shelter than such as can be improvised from the bark and branches of trees. Heavy woollen clothing alone can protect them from disease whilst sleeping on the wet ground which forms their nightly couch.

The *soldier's coat* should be a frock, fitting loosely, easy over the shoulders, with full play for the arms, without binding in any way, and wide in the body, so as not to impede the expansion of the chest when closely buttoned. In the Confederate service the jacket is now in very general use, and is preferred by our troops for its greater convenience in the performance of the drill, and in marching. Besides, from the constant bivouacking of our army and the sleeping of our men around fires, the tails of the coat are so frequently burnt off, to the detriment of the suit of clothing, that they have, on this account, been to a great extent dis-

carded. The *trousers* should be of good, heavy woollen material, made also free for the easy play of the limbs. When the bottoms are faced with leather or enamelled cloth, it is found a great protection in bad weather, and also from the dews, keeping the legs dry and warm. *Flannel shirts*, coming well down upon the thighs, and drawers of the same material, are of great hygienic utility, and should form a portion of the dress of every soldier, whether he has been accustomed to wear flannel or not. In winter they retain the animal heat and support the healthy function of the skin, while in summer they absorb more readily the excess of perspiration which occurs under severe exercise. While agreeable to the wearer, they prevent sudden arrests of perspiration, and are thus a protection against diarrhœa and dysentery, which are so fatal to armies. These should be furnished in sufficient numbers to enable the soldier to change his shirt when he has been exposed to rain, as he may thus prevent pneumonia and bronchial affections.

In the French service, where flannel underclothing is not in such constant use as in the English and American service, every soldier carries a band of flannel, with which he envelopes his abdomen, as a safeguard from abdominal affections. Baudens, one of the surgeons-in-chief of the Crimean service, speaks of this band as essential to the health of the troops, and, at the same time, refers to the much better and more convenient protection which the English flannel shirt gives to the men. The liability of losing the flannel girdle, and its very partial protection, is a serious objection to its use. For similar reasons, *heavy socks* should always be given to soldiers, as they retain warmth to the feet—which, being at the greatest distance from the centre of the circulation, are least

capable of resisting cold, and therefore require most protection against injury.

The feet are part of the person of a soldier so essential for the performance of military duty, that their condition should be particularly attended to by the officers. *The shoes, boots, or half-boots* should be well made, of good, durable material, and well fitted to the foot, so as to be easy to the wearer. The soles should be broad, thick, and firm, high-quartered, so as to exclude mud or sand, and closely fitting around the instep, so that tenacious clay can not easily drag it from the foot. A good shoe or boot adds often as much to the efficiency of the soldier as a good weapon. Marching is as necessary a quality as fighting, and is made one of the requisites in becoming a member of the Imperial Guard of the present French emperor. When the shoes do not fit the wearer who is compelled to use them, sore feet, a very troublesome complaint in the army, is brought on. From this cause, men on the march are found lagging behind from lameness, and are exposed to be cut off by marauding parties of the enemy. The leather should be well smeared with grease, oil, wax, tallow, or other composition, to make them water-proof, soft, and more durable. This should be done daily in wet weather. One pound of tallow and half a pound of rosin melted together, and applied hot with a painter's brush, and renewed until neither sole nor upper leather will take up any more, is found an admirable leather preservative. The grease alone would, in time, rot the leather, but the addition of rosin gives the compound antiseptic properties.

In the Crimean service the Russian half-boot was found so superior an article over the boots or shoes of the Allies, that they were sought for with avidity upon the dead, as soon as they were shot down, and were

more prized than any other article of wearing apparel, so conducive were they to the comfort of the wearer. They protected the feet perfectly from the mud in which the troops lived for months. Our government found so much difficulty in furnishing a sufficient amount of shoes, that our troops were often barefooted, going into battle over frozen ground without shoes, and after a victory supplying their wants from the Federal dead. After every battle, when the burial parties are ordered to their work, the shoes of the slain will have already disappeared. It was only by a general appropriation of clothing found on battle-fields, that many of our soldiers were made comfortable.

The French *gaiter* used in the Crimea was made of heavy white cloth, covering two-thirds of the foot, and extending some distance up the leg, usually over the knee. It facilitates walking, and prevents enlargement of the veins, while it protects the limb from cold and wet. Experience in the field and upon the march has proved them so serviceable, that the entire French army is provided with them. They, as a substitute for the boot, might be added with advantage to the equipment of the soldier. When made of leather, they become hard after getting wet, and, by pressure, excoriate the ankles. Beside which, the leather is cold in winter and very hot in summer. The only advantage in the leather gaiter is durability; the cloth wears out much sooner, and also becomes saturated with moisture in very wet weather. In addition to the gaiter, many of the French troops wear greaves, made of heavy patent leather, which cover the leg to the knee, shutting in the bottom of the pants. This gives them great facilities in walking, as it protects the leg of the pantaloon from becoming foul with mud, which is an endless annoyance to troops marching in bad weather

Every soldier should have an *overcoat* of stout cloth

reaching below his knees, with a cape covering the shoulders. This, like all other articles of clothing, should be made easy, to permit of every movement without binding. The French have added a hood, to protect the head and neck in bad weather from cold, wind, and rain, which is a great protection, diminishing the frequency of catarrhal affections. When on guard duty in bad weather, the hood is a great comfort, and it is also of great utility in protecting the head and neck from the damp ground when sleeping. Crimean soldiers found this addition a great improvement.

In selecting a *color* for a uniform, it should be remembered that light colors absorb less than dark; and, also, that odoriferous exhalations adhere with much greater pertinacity to dark than to light clothing, which is an item of no small importance, when the deleterious emanations accompanying large bodies of men are considered. Beside which, experience in battle shows that certain colors make much better marks to fire at than others; and, according to calculations, a soldier dressed in light cloth is much less liable to be hit than in dark. The following percentage is said to be the relative liability: red, twelve; rifle-green, seven; brown, six; Austrian bluish-gray, five. Red, which is the most attractive and fatal color, is more than twice as much so as gray, which is the least.

The best *military hat* in use is a light, soft felt, with a sufficiently high crown to allow space for air over the brain. The rim can be fastened up in fair weather; and, when turned down, protects, in a measure, from the rain or from the rays of the sun. In a warm climate, the light color of the hat adds much to the comfort of the wearer. The small, French, jauntily-fitting kepi is light, but does not protect the face; and, when made of dark materials,

concentrates the solar rays upon the head. This, however, can be in a measure obviated by adding a Havelock, which consists of a cap-cover with a long cape attached, hanging down upon the shoulders, which protects the neck from the sun in the day, and draughts at night. It is made of light cloth, of a light color, for reflecting heat. Those who have worn them on a march, or when exposed to the sun's rays, speak in extravagant terms of the comfort and protection which they give. The advantage of wearing a light and high-crowned hat is that, under exposure to the sun, as during a march, a small, wet handkerchief placed in the crown will not only prevent sunstroke, but will add much to the comfort of the soldier.

According to the army regulations of the Confederate service a soldier is allowed the uniform and clothing stated in the following table, or articles thereof of equal value:

CLOTHING.	FOR THREE YEARS.			Total for three years.
	1st.	2d.	3d.	
Cap, complete	2	1	1	4
Cap-cover	1	1	1	3
Coat	2	1	1	4
Trousers	3	2	2	7
Flannel shirt	3	3	3	9
Flannel drawers	3	2	2	7
Bootees,* pairs	4	4	4	12
Stockings	4	4	4	12
Leather stock	1	.....	.....	1
Great-coat	1	.....	.....	1
Stable frock (for mounted men)	1	.....	.....	1
Fatigue overall (for engineers and ordnance)	1	1	1	3
Blanket	1	.....	1	2

*Mounted men may receive *one* pair of "boots" and *two* pair of "bootees," instead of *four* pair of bootees.

In the field, there should be always a supply of clothing at hand, to replace the loss by unavoidable accident. During the Crimean service, Dr. McLeod informs us that the deficiency of clothing, which was so much complained of, was one of the most prolific sources of subsequent disease among the English troops. The truth of this statement was corroborated by our experience in the campaigns of 1861 and 1862, where a great amount of sickness could be traced to insufficient clothing.

Soldiers are expected to have always an extra suit of underclothing, and usually have an extra pair of pants and shoes. If at the weekly inspections, their clothing is found deficient, it is the duty of the inspector to report such instances to company officers, who are instructed to draw from the quartermaster such articles as are necessary for the comfort of their men. Should they have already drawn all the clothing which army regulations allow, the value of such extra clothing will be deducted from their monthly pay. This regulation, when attended to prior to a march, insures a change of clothing, which is essential to cleanliness and comfort.

One of the universally admitted maxims for preserving health in a campaign, irrespective of climate or locality, is, that *soldiers must protect themselves in summer from night air by warm clothing.*

A heavy blanket, not in name but in weight, and one and a half yards of india-rubber cloth, complete the equipment of a soldier. The india-rubber cloth is a water-proof covering for him during exposure, and will always make for him a dry bed, upon which he can find health as well as comfort.

We make the following extract, on the extent of a soldier's equipment, from Jackson's Formation, Dis-

cipline, and Economy of Armies. In the form and fashion of a soldier's equipment, "The adjustment of the kind and quantity of articles termed necessaries is a matter of importance, and as such requires to be well considered. It is demonstrably proved, to the conviction of all persons who have served with armies, that superfluous baggage—that is, baggage beyond the narrowest measure of utility—instead of bringing comfort to the possessor, is a cause of great annoyance and vexation. A complete change of the smaller parts of dress, in the event of being wet with rain, together with a cloak as a covering for the night, is all that a soldier requires for his comfort and the preservation of his health; and, as such, it is all that he ought to be permitted to possess. Where persons have not more than one change of raiment, the strong impression of necessity obliges them to prepare for the return of want. Where there is a superfluity, the necessity does not present itself so forcibly, and hence the dirty clothes are crammed into the knapsack, where they accumulate in quantity, without obliging the individual to recollect that they are not fit for use until they are washed. It thus often happens that a soldier who has four or more shirts in his possession, has not one fit for use—while a soldier who possesses no more than two, has generally one in his knapsack ready for the contingent occasion."

The following is considered to be a full equipment for a soldier on service, namely: two flannel shirts; two pair of heavy socks; two pair of flannel drawers; two pair of shoes, or one pair of shoes and one of half-boots; one pair of gaiters; a small case of needles, thread, and buttons, for mending clothes; one small shoe-brush, with blacking; combs and hair-brush; tooth-brush; one piece of soap; a sponge for washing

the body, and a towel for drying it; two pocket handkerchiefs; an overcoat of heavy material, besides his uniform. He should also have a heavy blanket — better if lined with stout osnaburgs, to increase its durability and warmth — and two yards of india-rubber cloth to protect him from the weather. He should also carry a knife, fork, and spoon, a canteen for water, and a haversack for carrying dressed provisions. If those articles of clothing not in use be put up in a neat and compact manner, and enveloped in oiled cloth so as to be secure from wet, and deposited in the knapsack for easy carriage, the soldier will not be incommoded by their bulk or encumbered by their weight; and, possessing within himself everything actually necessary for use, will be independent of the delays and accidents so common to the baggage-wagons.

In the above list we have purposely omitted shaving apparatus, as every soldier in the field should allow his beard to grow. It protects his throat, and often prevents lung diseases, catarrhal affections, etc. A heavy moustache is known to protect the wearer, to a certain extent, from malarial influences, acting as a sieve to the lungs. It also purifies from dust the atmosphere inhaled during marches, and thereby prevents many troublesome diseases. Cleanliness dictates that the hair be cut close to the head, and, although the beard be allowed to grow, it should also be kept within bounds.

Cleanliness.— Nothing contributes more to preserve health than personal cleanliness; and as the free use of soap is a prophylactic as well as a civilizer, it should be regularly distributed to the men. Daily ablutions should never be omitted; and, if possible, the chest and arms, as well as the face and neck,

should be well sponged. Baths should be used whenever opportunity permits. Whenever our troops encamp near a stream, it is now the practice of careful officers to have the men marched down by company to bathe, and this is repeated as often as cleanliness requires. *Keeping the skin clean prevents fevers and bowel complaints in warm climates.* The large experience of our various campaigns only confirm the fact that the most cleanly are always the most healthy. Baudens, in insisting upon cleanliness, says, "That the contrast in the sickness and mortality of the English and French camp in the Crimea can be, in a measure, attributed to the frequent ablutions of the English, who washed their clothes in *hot* water, and changed their underclothes twice a week. It is easy to understand how carelessness in this respect will impair the functions of the skin, and induce disease. At review our French soldiers show new clothes, and, on the whole, an unquestionable military equipment, yet these beautiful battalions leave in their passage a strong smell of barracks not to be mistaken."

Not only the tents, but the persons of soldiers as well as their clothing, should be daily inspected. However particular men may be in civil life, as soon as they are put into the field not only are all habits of cleanliness neglected, which we would have supposed had been incorporated with their very nature, but men seem actually to take pleasure in being careless, and comment upon the little need of corporeal ablutions. Days pass without the use of water, and filth and vermin soon reign triumphant. It requires time to prove to volunteers the fallacy and dangers of such a course, which a sad experience corrects. The result of this carelessness, during the first year of the war, was that lice, which are an accompaniment of armies,

were no strangers to our soldiers. The careless were covered with them, and infected all their associates, from the general to the private, and only with the utmost care could the cleanly keep themselves aloof from this disgusting companionship. One of the strongest reasons why regulars enjoy better health than volunteers, is that the one are daily inspected by their officers, who insist upon their faces being washed, heads combed, etc.; while the volunteers, with whom the regulations of a strict discipline are not enforced, are allowed to abuse the privilege of following the bent of their own inclinations. In the beginning of the war it was deplorable to see the condition of our best society in camp. Then, in the Confederate hospitals, it was not rare to administer the first bath to volunteers who had been six months in service, without ever having used water beyond their faces. It would be a sanitary regulation of great value, if general ablutions could be made a portion of the daily drill. A heavy penalty of extra fatigue duty should be imposed upon those who did not daily meet the requirements of hygiene and cleanliness. As the necessity for a more rigid discipline has become apparent both to officers and men, the lines have been gradually drawn, until at present our army of volunteers, with independent views of the duties and obligations of soldiers, have imperceptibly merged into a body of regulars, governed by those strict rules which military experience has shown indispensable to the sanitary condition of an army; and hygiene, in all of its details, is now much more carefully observed. The frequent inspections of staff officers have stimulated both medical and line officers to a more rigid performance of their duties, and hygienic regulations are now enforced. He is not only the

best, but also will become the most popular officer, who attends himself to all these detailed comforts of his men.

FOOD of the soldier should be plain, nutritious fare, well cooked, which, with exercise as an appetizer, he will find no difficulty in enjoying, however monotonous his daily ration may be. For a working man (and where do men labor more than the soldier in the field?) the diet should be of a mixed character, and food should be of the variety easily cooked. The character of the diet, however, must depend, to a certain extent, upon the seasons, and the ability of the commissary to meet the demands of the army. Highly-seasoned dishes are neither possible nor desirable for the soldier. Toil, fatigue, and often hunger, will make any wholesome food savory. "The plain repast is sufficient for sustenance; and a plain repast gives all the gratification to the palate of a hungry and thirsty man that a soldier ought to permit himself to receive."*

For the English there is no beverage like tea; and a military writer remarks that a breakfast of tea, with bread, enables a person to sustain the fatigues of war with more energy and endurance than a breakfast of beefsteak and porter. The French prefer coffee, to which they give the highest prophylactic virtue. This is the stimulating drink of the troops, and its free use makes the men much more healthy and cheerful.

As neither coffee nor tea can be obtained by our troops, inasmuch as the stringency of the blockade excludes both of these articles from commissary stores (except in small quantity for hospital use), whis-

*Jackson's Economy of Armies.

key at times becomes a necessary issue to sustain the health of the army under severe trials.

The Turks place great reliance on coffee as a preservative against dysentery; and McLeod states, as a result of his Crimean experience: "I have no doubt that, if the precaution had been taken to supply the troops every morning with hot coffee, as they went on or returned from duty, much of our mortality might have been avoided."

As roasted and ground coffee has become a fixed article of trade, it would be much better for the troops if it could be served out in this form, mixed with a due proportion of sugar, particularly when they are upon extra duty, as it not only saves them much time, but insures the proper preparation of a supporting beverage.

If coffee can not be obtained, the best substitute is a pint of hot soup, which might be prepared from fresh beef when this article is abundant; but, what is still better for army purposes, from a spiced soup-cake, which is made of choice portions of beef, farinaceous ingredients, and spices—the whole cooked, compressed, and desiccated. These cakes occupy but a small space, can be easily carried, will keep for months; and, by cutting them up in the proportion of a pint of boiling water for each cake, and allowed to boil for ten or fifteen minutes, a pint of excellent, well-flavored soup can be made. It requires no longer to make a pint of good soup, with one of Jones' soup-cakes, than would be required to make a cup of coffee, with the coffee already parched and ground.

On account of the very great exposure to which our troops must submit, without the protection of tents to shield them from the drenching rains or the heavy nightly dews, when it could be obtained, a dram of

whiskey, issued as a ration, has been found very beneficial in sustaining the health of our men. From the scarcity of this, with all other stimulants, its use has not been general, nor continued for any length of time; but when it could be procured, the advantages of the issue were very decided. In the malarial region upon the coast of South Carolina, among the swamps and rice fields of this very insalubrious country, a daily issue, during the summer months of 1862, of whiskey medicated with an infusion of tonic barks, was found to produce the most decidedly beneficial effects on the appearance and condition of the men—filling the ranks, and improving the physique of companies—when, before its use, the force of the regiments, broken up by climatic diseases, was represented only in hospitals.

It may be needless to say that good water is even more necessary than good food, and should be obtained, at any cost, for the use of the troops. There is no one item so prolific in disease as drinking bad water—so strikingly exemplified in the Western Army at the time of, and after, the Battle of Shiloh, when, from the scarcity of good water, and the filthy, muddy condition of the little which could be obtained, an epidemic of diarrhœa and dysentery, with typhoid complications, decimated, and at one time threatened to destroy our army. Should troops be so unfortunate as to be in a place where stagnant or ditch water has to be used, it can be purified by boiling with a lump of charcoal; after which it should be freely agitated in the air, to restore to it the vivifying properties which the heat had driven off. Should the water be turbid, a piece of alum thrown into a bucketful will quickly settle the deposit and restore its crystalline character. If more time be allowed, the

better plan would be to filter the water by sinking a barrel with holes bored in the side; into this a much smaller barrel, with the bottom knocked out, is placed, and the intervening space between the barrels filled with straw. The water which passes through the holes leaves all impurities upon the straw, and springs up as clear, potable water in the smaller barrel.

Fresh meat is a frequent issue to armies, and is the most common issue to our troops. It is usually boiled or roasted over the fire into a tough mass, known as frizzled beef, which tests the capacity of even a soldier's digestion. The proper mode of cooking this ration is in soup, which is always palatable, whether thickened with flour, hard bread, or such vegetables as the country affords. A French military proverb says that "Soup makes the soldier." In the use of fresh meat, let it always be remembered that a fundamental rule in the culinary art is to boil meat slowly and roast it quickly.

The free use of fresh vegetables is the only mode of preventing the appearance of scurvy among the troops. When these can not be obtained, the free use of dried vegetables, as rice, potatoes, corn meal, etc., will tend to sustain health and vigor.

A distinguished military surgeon has remarked that 100,000 francs spent in fresh vegetables will save 500,000 francs from the expenses of sick soldiers entering the hospital, beside the use of the men for active service. Of the dried vegetables, rice is among the best for feeding troops. It is easily carried, easily cooked, easily digested, and is one of the most wholesome of the farinaceous articles—correcting, as it often does, the tendency to intestinal fluxes, and yet in the rice-growing country of the Confederate States it is issued very sparingly to our troops.

In the Crimea, where the temporary absence of fresh vegetables was a great and serious privation, lime-juice, citric acid, and sour-crout were extensively used to prevent and stop scurvy. Acid fruits are antiscorbutic, and very good for soldiers. The English, in the Crimea, gave out a ration of lemon-juice three times a week, which, when mixed with rum and sugar, made a very nice, healthy drink. This corrective protected, to a certain extent, the English soldiers from scurvy, while with the French it was widely epidemic and very fatal. Vinegar, when freely distributed, also assists in preventing this scourge among troops. Vinegar, molasses, and water, when mixed in proper proportions, make a very refreshing and palatable drink, not unlike lemonade, and possessing similar antiscorbutic properties to lemon-juice.

Scurvy has often appeared in our armies, and during the spring of 1863 it was quite prevalent in the Army of the Potomac. It was corrected by the issue of antiscorbutics, but more especially by the use of wild herbs, which were collected by men sent out for that purpose. With beef and the herbs an excellent soup was made, which was found the best corrective for the scorbutic symptoms.

One of the worst articles which can be issued to troops in the field, without conveniences for cooking, is wheat flour. Fresh bread all will acknowledge to be good fare, and is always hailed with satisfaction; but to issue raw flour as the vegetable element of a ration, with no means of cooking it into an edible bread, is an act of cruelty to troops who have no means of obtaining other food than that which the commissary department allows. In our corn country, where corn meal or grist is a common article of food, a staple liked by all, and the mode of cooking it easy

and familiar—the article itself abundant, cheap, and forming the very best of food for man—why this article should not be generally issued instead of unwholesome flour, which can only be made into the most indigestible of dough-cakes, into which the teeth stick in vain attempts at mastication, can not be satisfactorily explained. Economy, the health of the troops, and general satisfaction in the army, would be the result of the change from wheat flour to corn meal. If orders were issued to carry portable ovens with the troops, so that good bread could be daily prepared, which can very easily be done, or if ovens were built wherever troops locate, then would flour be a useful issue.

Biscuits, or hard bread, is a common article of diet in camp life, because it is easily preserved and transported. When eaten as dry biscuit, it acts like a sponge in the mouth, exhausting salivary secretion. When possible, and rarely is it inconvenient, soak it in tea, coffee, or soup; it then makes a very nutritious meal. Even water, with a little salt, makes hard bread much more palatable and nourishing. When boiled with sliced bacon and water it is a very satisfactory meal for our soldiers, one always relished, but not very often enjoyed.

Necessity, the parent of everything useful, even in the domestic economy of armies, has driven our soldiers to a method of using their flour ration which, in absence of other fare, makes a palatable and an edible bread, which is known in the army as Confederate Biscuit. It is prepared as follows: Cooking utensils being of the most simple character and of the smallest possible number in our army, a mess-pan, camp-kettle, or even tin cup, is often found to embody all the requisites for cooking the daily meals. Where extra

cooking is desired, apparatus must be improvised. A piece of bark or the head of a barrel composes the kneading-trough, upon which the flour is worked with salt and water, or with melted grease, when the beef issued can supply tallow. This mass is either baked or fried in a pan; or, drawn out as a cord, is twisted around a ramrod, and baked over the fire. When the army is moving, and cooking utensils can not be got at, a hole scooped in the ground with a bayonet makes a ready mixing-bowl, and the ramrod, always at hand, completes the paraphernalia of the kitchen. The bread made in this way is reported excellent. Fresh bread is always preferable, when it can be obtained.

Bacon is, par excellence, the laborers' and soldiers' meat in America, and goes further, by weight, than any other. It never produces surfeit, is always acceptable, very easily cooked, and, with its rich juice, will make the dryest farinaceous diet savory. It has the very great advantage, when properly cured, of keeping for a length of time, under any condition, which makes it far preferable to any other meat for troops. It can also be eaten raw, as on a march, when neither time nor convenience exists for cooking it. Our soldiers, who are very often forced to this alternative, have not, apparently, suffered from its very frequent repetition.

In the Confederate service the full ration, which our troops have seldom issued to them, consists of three-quarters of a pound of pork or bacon, or one and one-quarter pounds of fresh or salt beef; eighteen ounces of bread or flour, or twelve ounces of biscuit, or one and one-quarter pounds corn meal; and at the rate, to one hundred rations, of eight quarts of peas or beans, or, in lieu thereof, ten pounds of rice, six pounds

of coffee, twelve pounds of sugar; also, four quarts of vinegar. The ration is completed by adding one and one-half pounds of tallow, one and one-quarter pounds of adamantine, or one pound of sperm candles, four pounds of soap, and two quarts of salt, to one hundred rations. On a campaign, or on marches, or on board transports, the ration of hard bread is one pound.

Extra issues of soap, candles, and vinegar are permitted to the hospital, when the surgeon does not avail himself of the commutation of the hospital rations, or when there is no hospital fund.

Desiccated vegetables may be issued once per week, in lieu of beans or rice; and should a tendency to scurvy appear among the troops, the commanding officer may, by advice of the medical officer, direct their more frequent issue. Two "issues" per week of "desiccated vegetables" may be made in lieu of beans or rice.

Potatoes and onions, when used, will always be in lieu of rice or beans. Potatoes at the rate of one pound per ration; onions at the rate of three pecks per hundred rations.

When fresh beef can be provided, so as to cost not more than an equivalent of salt pork, it is issued to the troops five times a week. It has often occurred that beef was the sole meat issue for weeks continuously, and as often the army would be for days without an issue of meat of any kind—hard biscuit or wheat flour being the sole article of food used. Often has a few ears of corn to man and horse been the day's ration in our army.

When, from excessive fatigue or exposure, the commanding officer may deem it necessary, he may direct the issue of whiskey to the enlisted men of his command, not to exceed a gill per man for each day.

Tea may be issued in lieu of coffee, at the rate of one and a half pounds per hundred rations.

When the officers of the medical department find antiscorbutics necessary for the health of the troops, the commanding officer may order issues of fresh vegetables, pickled onions, sour-crout, or molasses, with an extra quantity of rice and vinegar; potatoes are usually issued at the rate of one pound per ration, and onions at the rate of three bushels in lieu of one of beans. Occasional issues (extra) of molasses are made —two quarts to one hundred rations; and of dried apples, of from one to one and a half bushels to one hundred rations.

When antiscorbutics are issued, the medical officer will certify the necessity and the circumstances which cause it, upon the abstract of extra issues.

Such are the supplies which our troops would be allowed to have in peace times, and in the beginning of the war most of the articles may have been issued; but the army has not, for many months, enjoyed the privilege of whetting their appetites upon this attractive bill of fare of the commissary-general's. Habit has taught them to live upon a much smaller list, and in much smaller quantity. From the scarcity of many of the articles enumerated above, they have been rescinded from the issue, and the ration has been reduced to its simplest form of beef and flour. Owing to a badly-organized and deficient transportation, one portion of the army is surfeited with such things as another division seldom sees. Notwithstanding the scanty and very indifferent fare, our veteran troops, who have become accustomed to it, sustain robust health.

Daily issues of rations should be made to the troops; for when, from the laziness of commissaries, two or three days rations are given out at a time, through

the proverbial carelessness or improvidence of soldiers, the provisions are either wasted or all are eaten in one day, and two days' starvation, if not sickness from gormandizing, follows.

As soldiers are expected to cook their own provisions, and as all are familiar with the fact that as much depends upon the mode of cooking as upon the articles cooked, it would be better to have one of the mess appointed special cook than to allow the soldiers to cook in turn. A division of labor is clearly the preferable plan. It would be economical and beneficial, if government would allow two professed cooks for each company, as the health of the army would be improved materially by having good fare. Firewood, of course, must be liberally provided, as it is one-half of a soldier's existence.

The entire health of troops depends upon the quality, quantity, variety, and the regularity with which the provisions are supplied. The effective condition and strength of the army, with a diminution of the sick, and consequently a diminution in the hospital expenses, will depend, in a great measure, upon the commissary department. In 1847 the high price of provisions doubled the number of sick in the French army, sending one-fifth of the effective regiments into the hospitals. The better paid, select corps, who could increase their supply of nourishment, escaped those diseases which prevailed among the common soldiers. Experience shows that, in a besieged city, when scarcity prevails, pestilence follows in the wake of famine.

Officers as well as soldiers usually club together into messes, which is not only more agreeable, but also profitable for all concerned.

Officers' messes should consist of the company offi-

cers—four persons. The colonel, lieutenant-colonel, major, adjutant, and sergeant-major, with the commissary, quartermaster, surgeon, assistant surgeon, and chaplain, could easily arrange two or three messes.

Messes of privates and non-commissioned officers should number six persons, for obvious reasons, so that the details for guard duty would always leave four in charge of the tent.

Articles wanted for a mess of six, when transportation is abundant, and articles readily obtained: Two champagne baskets, covered with coarse canvas, with two leather straps with buckles; six tin plates; six tin cups; six knives and forks; six bags for sugar, coffee, salt, etc., to hold from half a gallon to one gallon; one large-size camp-kettle, one iron pot, one bake-oven, one frying-pan, one water-bucket, one lantern, one coffee-mill, six spoons, one tin salt-box, one tin pepper-box, two butcher-knives, two kitchen-spoons, two tin dippers, one teapot, one coffee-kettle. Two years' experience, the rapid movements of our army, and deficient transportation, with the impossibility of supplying the wear, tear, and loss of camp utensils, have modified the list of necessary culinary articles, and our soldiers are now accustomed to prepare their rations with very little in the shape of cooking utensils. If each man has a tin cup, and each company a camp-kettle, one or two frying-pans, and an axe to cut wood with, they would consider themselves well provided with all necessary apparatus. In the present condition of the cooking utensils of our army, one wagon readily carries the cooking paraphernalia of a regiment.

It is always a good rule to accustom an army to adopt the modes of living common to the inhabitants

of the country in which the army is found, as certain peculiarities of living are naturally adapted to certain climates.

Although war brings with it privations and irregular living, which it is impossible to prevent, the mode of living of a soldier, to a certain extent, should follow a fixed standard. His meals should be equally distributed through the day, and he should never be put to work without having broken his fast, however light the meal be. In camp, soldiers should live with regularity, and the breakfast and dinner hour should be respected; and as three meals a day is the custom of our people, this regulation should be adopted. It is on the march that circumstances prevent the carrying out of rules, and that our troops suffer the greatest privations. Very few armies have been more exposed, and suffered more from hunger and fatigue, with so little dissatisfaction and straggling as ours.

The following is the order which experience has proved to be the most useful in the Confederate army: Our troops are accustomed to move at short notice, and, therefore, often with empty haversacks, and no prospect for a meal during the day. When a march has been determined upon, the ration (which is now one pound of flour and half pound of bacon, the latter being usually issued in lieu of beef when troops are under marching orders) is cooked in advance, or bread may be issued, which, with raw bacon, will make a palatable meal. Usually, three days rations are served and cooked prior to moving, and under these conditions a hasty meal will be taken before falling into line. Our men have neither the hot cup of coffee or tea, nor have they the hot soup, nor drink of whiskey, which is the marching preparation of an army with a more extensive commissariat than ours.

They move with alacrity, and often break their fast while in motion. The start, especially in summer, should always be at the break of day. After marching three-fourths of an hour, the column stops for twenty minutes. In resuming the march, a halt is made for ten minutes after each hour. From twenty to twenty-five miles a day is considered good marching for an army, although, on an average, it does not exceed fifteen, and may be divided in the following order: Nearly three miles may be made during the first hour of marching; then a halt is ordered for twenty minutes, during which the men should remove their knapsacks and recline upon the ground, as standing gives but little relief. Two miles an hour can be made for the remaining portion of the day. After marching for three or four hours, a halt should be ordered, especially in summer, until the heat of the day passes, when the march may be resumed. During the mid-day rest, if any opportunity exists, the shoes and stockings should be removed and the feet bathed, which, by removing dirt and acid secretions, will prevent excoriations. It may also be advantageous, at such times, to change socks from one foot to the other, so that the seams may come at different portions of the foot, which will prevent continued and injurious pressure. Soaping the sock will also prevent excoriations, and add much to the comfort of a soldier while on a march.

In crossing a river, when there are no bridges, the men ford it, and continue the march in their wet clothes, until they dry. It is found that when they are allowed, as they are in European armies, to take off their pantaloons and shoes, that much delay is occasioned, and the column is thrown thereby into disorder. A sentinel guards any fresh-water spring

which is met in the march, to deter soldiers from gorging themselves—a very wise measure, which prevents much sickness. An aphorism worthy of remembrance is—*Drink always before marching, and while on the march moisten the mouth often, but drink seldom.* Water should always be taken in reserve, and with precaution. When taken in great quantities, it weakens and fatigues the organs of digestion, increases perspiration, and enervates the entire system. It is particularly injurious to drink rapidly and freely when heated from exercise, as sudden death sometimes follows this imprudence.

The soldier should accustom himself, when thirsty, to drink slowly and in small mouthfuls, keeping the water in the mouth and throat as long as possible. The cravings of thirst are often produced by a parched condition of the lining membrane of the mouth; and by rinsing the mouth frequently, thirst can be allayed to such a degree that but little water will be required, while much, hurriedly drank, will not satisfy the urgent call. In marching, thirst can, in a measure, be prevented by keeping the mouth closed, and in speaking as seldom as possible; otherwise, the dry air, often loaded with dust, will parch the lining membrane of the mouth—a very distressing sensation when it can not be relieved by drinking. Arabs, in crossing sandy deserts, where but little water can be found to allay the intense thirst of their hot climate, adopt the wise precaution of tying a handkerchief over the mouth, which keeps out dust, and, by preventing conversation, prevents, to a great extent, thirst. It would be well for troops upon a march to profit by their experience.

When, during a march or halt, the fatigued and thirsty soldier finds water, instead of rushing to it at

once, he should first try and repose himself before drinking; then, having washed out his mouth several times, drink slowly, so as to make the smallest possible quantity of water supply his necessities. Washing the face slackens thirst. When water can not be obtained, a bullet or pebble in the mouth, or chewing a green leaf, will cause a secretion of saliva, and, by keeping the mouth moist, will temporarily allay thirst. As good water is not always to be obtained on a march, a soldier should never lose an opportunity for filling his canteen with fresh water. If the canteens be covered with a light-colored woollen cloth the water will keep cooler than in bright tin, which absorbs heat more rapidly, and extends it to the contents of the canteen.

When troops have had an early start, and are not marching in the face of an enemy, they should bivouac about ten o'clock in the morning, and lie over during the heat of the day, as soldiers on a march should, if possible, be protected from the midday sun. Here they will have time to cook their mid-day meal, and refresh themselves from their fatigue. The experienced soldier never forgets to keep in reserve a certain proportion of meat or other food, against a deficient distribution, or the want of time for properly preparing it, during the continued march. The want of this precaution, which old soldiers adopt, is severely felt by recruits. The meal should be taken in the shade, under some protection from the sun. A few branches, properly arranged, will form a comfortable shelter. The main meal of meat, etc., should be taken after the evening halt, at the end of the day's march.

The officer in charge of the troops should always know the road over which he is to travel the next

day, and when he is compelled to bivouac in places where the prospect for getting wood is bad, each soldier should carry on his knapsack a small quantity to cook his mid-day meal with.

When troops are ordered on a forced march, or on scouting service, their food should be prepared in advance, for two or three days rations, or they should be furnished with such as can be rapidly cooked; sausage or meat-cakes, with biscuit, would be an excellent issue at such times.

In the evening halt, which should be at about five o'clock in the afternoon, so as to allow the men to improvise camp comforts, the site selected for the camp, when possible, should be on rising ground, free from low places, and in proximity to water and wood. These rules become of special importance in establishing a camp for even a few days' stay. It is prudent to avoid the immediate vicinity of swamps and rivers; the emanations from such are noxious, often pestilential, but fortunately do not extend to a great distance. Interposing a piece of rising ground or wood is, as a general rule, sufficient to turn or break currents from these low places, and protect from their hurtful influence. It would be preferable to camp in the direction of the regular wind currents, so that emanations may be wafted in the contrary direction.

When the halt is only for the night, although the camp-wagons, with the tents for the officers, may have come up, they prefer, with the men, to bivouac under the clear sky, or seek shelter under a few branches, with which they form a rough shed that will protect them from dew. The bivouac is, from necessity, the mode of living of most of our troops during the active campaign, which extends over several months of each year. At the breaking up of the winter encampment,

all tents, with the exception of a few for the use of officers, are turned over to the quartermaster, to be transported to some depot in the rear, where they remain, unless the army, in manœuvering, occupies a position which it will retain for a lengthened period, when the tents are again issued. As our troops move with celerity, and as transportation is always deficient, it is a desideratum to march with the smallest amount of baggage, and our men willingly leave their tents—even field-officers preferring the protection of their blankets and india-rubber cloths under the open sky, to the trouble of unloading their wagon of its camp equipage. If possible, dry grass or leaves form their bed, and, lying in their great-coats and upon their india-rubber cloths, they can enjoy peaceful slumber.

In marching through a wooded country, as is our own, it is surprising to see with what dexterity a mess can build for themselves a shelter for the night. On a regular march the column usually halts for the night at about five o'clock in the afternoon, which gives the men ample time to prepare their hut or tent, after the following method: Two sticks, four and a half feet long, with a fork at one end, are planted in the ground, a ridge-pole placed in the forks. A large blanket thrown over the ridge forms a comfortable tent, which can be perfected in ten minutes; or branches may be laid either side of the ridge-pole to the ground, which would enclose the area of a tent. In summer it is preferable to cut the forked sticks longer, and, leaving one side of the shed opposite to the direction of the wind open, incline the branches only upon one side, which will give those sleeping under its sloping roof protection from the dews or rain, and also, to a certain extent,

from malarial emanations wafted by the currents of air over the temporary resting-place of the army.

If there is no cover for the men, then they build fires, and sleep around these—lying as so many radii of a circle, the feet of the sleepers being nearest to the fire. Singular to say, this kind of rough life does not bring with it disease, as one would suppose. If the men are warmly clad, they always enjoy more health when bivouacked than when under tents; and as experience has taught our men the advantages of this life in the summer months, they leave their tents behind without regret, and with them such contagious diseases as had clung to the army while they remained in their permanent camp. Necessity has also forced some of our veteran troops to dispense with all shelter; even during the bitter cold of the past winter, the only cover which the men had being the leafless trees of the forest. The army, in constant motion, would lay down at night by their camp-fires, and, after a sound night's sleep, our soldiers would often find themselves in the morning nearly buried in snow. They would shake off the snow, rekindle their fires, and at least enjoy the satisfaction of never suffering from catarrhal affections.

No troops should ever bivouac upon damp, marshy soil, where a single night's exposure in summer would poison numbers with malaria, or in winter would be the fruitful cause of pneumonia or rheumatic affections.

The site of a permanent camp should be dry, with good drainage—the dryness of the soil being tested by digging, to see that a stratum of water does not immediately underlie the crust. In cold, damp countries, the material for tents should be close, and, as nearly as possible, water-proof; and when pitched, a good

ditch should be dug around them, with the earth banked up against the tent to keep out the cold and rain. When troops in the field go into winter-quarters, it is customary to build for their protection log-houses, cabins, or huts, covered in with boards, long segments of bark, or with a fly. At times, deep holes are excavated, and roofed over with planking; a ditch around the enclosure, which should be always deeper than the excavation, and filled with loose stones, will keep the apartment dry. In a very cold climate these make, perhaps, the warmest and most comfortable of winter-quarters.

The method commonly adopted in our army for warming tents, is to construct a chimney at the back of the tent, of sticks built up in pen-form, well covered with clay, and capped with a flour-barrel—the open portion in the tent being formed by arranging two rows of upright sticks three or four inches apart, forming three sides of a square, the interval between which rows is filled with clay. The back of the tent is slit, and the edges secured closely to the sides of the chimney, which throws the fireplace into the tent, and makes very comfortable, warm quarters.

An excellent mode of making a tent comfortable in cold weather, is by excavating a basement about three feet deep, which will at the same time give more room, and permit of a stove or fireplace in the centre of the tent. The dirt from within should be banked up against the outer side of the tent, to keep out cold and moisture. Communicating ditches should be provided, to facilitate drainage. Of tents, the circular offers the best protection against the wind, is least liable to be blown down, and is most useful for winter.

The light shelter-tent of the French troops, as

introduced by Marshal Bugeaud, is found most convenient during the summer months for an army in the field, and has been generally introduced into the Confederate service as the army tent. The tent is made of the knapsack of the soldier, which, instead of being sewed up, has its sides buttoned together. When unbuttoned, it is a square piece of cloth. When two or four sacks spread open are thus united, the centre supported by two sticks three feet long, and the angles staked to the ground by small camp-pins, the two or four persons to whom the sacks belong, by thus joining property, have a tent that will keep them from exposure to the sun, and also protect them from rain or dew. This tent is not more than three feet high at its ridge. In hot and dry weather, instead of pinning the two sides to the ground, one of them can be hung horizontally to branches of trees, leaving one side open for thorough ventilation, while the horizontal portion protects the sleeper from undue exposure. The size of this tent can be increased to any extent by joining stock, as all such sacks are of the same size, with buttons and button-holes arranged equidistant.

By employing this excellent suggestion, you avoid loading the shoulders of a soldier, or transporting tents for the army, which is often impracticable. In a few minutes after the day's march has terminated tents are pitched, and the camp assumes its regular appearance, without waiting for the baggage train.

Rider's tent-knapsack is made as follows: It is composed of a piece of gutta-percha cloth, five feet three inches long by three feet eight inches wide. Two of the borders are pierced with button-holes for brass studs, a third border has a double edge, between which may be inserted and buttoned a second knap-

sack, while the fourth edge would have the straps and buckles necessary to close the knapsack. The weight of the gutta-percha sheet, when prepared, is three pounds. The additional accoutrements carried by the soldier are two sticks, three feet eight inches long and one and a quarter thick, which may be divided in the middle, with the pieces securely attached to each other by a ferule; also a small cord. When used as a knapsack, the clothing is packed in a bag, and the gutta-percha is folded around it, lapping at the ends, so that the clothing is protected by two or three thicknesses of gutta-percha. Four knapsacks buttoned together will form a sheet ten feet six inches long by seven feet four inches wide, and when pitched on a rope three feet four inches above the ground, covers an area of six feet six inches wide by seven feet four inches long, which will accommodate five men, and may be made to give shelter to seven. The sheet can also be used upon the ground, and is a great protection against dampness.

In a regular camp the *soldier's bed* should never be directly upon the ground—as the earth always contains moisture enough to permeate the clothing, and rheumatism, pleurisy, pneumonia, and such kindred affections, may be the consequence. If beds can not be obtained, branches or dried leaves or straw should be used, upon which the blankets are spread. An elevated bed can be made by supporting rails upon four forked sticks with riding pieces; leaves or straw put upon these, and covered with a blanket, will make an excellent couch. This answers the double purpose of keeping the body from the damp ground and of elevating it into a layer of purer air. When the tent is filled, as is usually the case, the exhaled air, loaded with carbonic acid and other impurities, settles to the

ground. Unless free circulation of air is permitted in the tents, persons sleeping upon the ground would be continually inhaling this poisoned atmosphere, to their injury.

The soldier's bed should be always dry. All moist, decomposing materials, such as green grass or leaves, collected in a tent for a permanent bed, are more injurious than sleeping upon the soil, owing to the gases escaping from their decomposition. True economy would dictate a painted cloth for the floor of the tent, as this would prevent the exhalation of moisture from the earth's surface, is convenient, always ready, and less expensive than straw. It can be cleaned every day with little trouble, without cost, and requires to be freshly painted only once a year.

When straw or hay is used for bedding, it should be renewed as frequently as possible, and the straw should be turned, well beaten, and thoroughly aired daily, with exposure to the sun when possible. In the French camp, straw is given out every fifteen days; in our army regulations twelve pounds is allowed per month in barracks.

As a soldier always sleeps in his clothes, if he has a thick bed of dry straw to lie upon, he can cover himself with his blanket; but if otherwise, he should lie on his blanket, well doubled, to protect him from the damp soil, and cover with his overcoat. If he has an india-rubber cloth, he should always lie upon it, as the very best use he can make of it to protect himself from disease. It is an excellent substitute for straw in field life, more cleanly, and protects better from dampness; it is always at hand, and always ready for use. Sheepskins were tried by the French as a substitute for straw. They were found to attract moisture and propagate vermin, and were therefore rejected.

As the tent is always too small for the number which occupy it, the inmates should sleep with their heads as far as possible from each other. In the circular tent, they should sleep with their feet toward the vertical axis and their heads around the periphery, so as to increase to the utmost their respective areas for respiration. After *reveille* the tents should be opened, sides thoroughly beaten, straw turned, and exposed for several hours.

Extreme cleanliness should prevail within and without the tent. In an encampment the tents should never be crowded, but ample space should be left around each tent for changing its position at least every week, so as to purify the soil infected by habitation. The earth floor of a tent attracts and absorbs impurities which, unless changed, would soon render it a source of disease. Permanence of camps rapidly induces infection. This frequent changing of tents gives, to be sure, additional trouble to the officers and men who may not appreciate its advantages, but this is more than counterbalanced by the health and efficiency of the command. All the garbage of the camp should be thrown at a distance from the tents, and should be buried every evening.

The privies or sinks for the men are ditches, from three to five feet deep and three feet broad, screened from view by branches stuck in the earth. A crotched stick is driven into the ground at each end, and a pole laid across to serve as a seat. These sinks should be dug narrow and deep, so as to leave as little space as possible for evaporation. Usually three sinks are dug for each regiment, viz: one for the men, one for the use of line officers, and one for the field and staff officers. The common laws of hygiene insist that these be prepared immediately

upon the establishment of an encampment, and that the men be compelled to use them under a penalty. The want of these, and the negligence in insisting upon their use, may be considered one of the chief causes of the fearful amount of sickness which existed in the summer of 1861 in our armies. Gentlemen who composed our volunteer regiments would not obey the orders to use these sinks, and as the officers did not insist upon what the men objected to as unnecessarily troublesome, the result was that, with but few exceptions, our regimental camps were accumulations of filth of every description, which could be detected at a distance while approaching them. It was not surprising that disease and death followed in the wake of such indifference to all laws of decency and hygiene.

As soon as a camp is established, the quartermasters of regiments locate the sinks, and fatigue squads prepare them for use. A patrol guard is then established, whose duty it is to see that the grounds about the camp are not defiled. All delinquents are punished with fatigue duty in policing the camp under the guidance of the officer of the day, who always has under his charge a number of unruly men, who pay the penalty of infringing military rules by devoting all of their spare time to the cleansing of the camp, in burying offal, and in digging new sinks when those in use have been sufficiently filled. Under the feeling of responsibility which is now felt in the army, and the more stringent reports of brigade and division inspectors, a much more wholesome condition exists in enforcing such sanitary regulations of cleanliness, etc., as the massing of men absolutely require.

The privies should be placed at least one hundred yards from the tents, and in an opposite direction

to the wind currents, so that offensive odors will be blown away. Where proximity to the water permits, they should be established over the running stream. This will remove a great and common source of infection, which is very difficult to counteract. The slaughter-pens should also be placed at a similar distance. Every evening the offal of the day should be covered with three or four inches of earth, or a sufficient layer to prevent any smell arising from the day's deposit. When the trench is two-thirds full it should be closed, and another of similar dimensions opened.

In permanent camps, dead animals, horse-dung, and all animal refuse, should be buried, otherwise the stench from them would be very injurious to the health of the troops. But as, notwithstanding the utmost care, in the most salubrious situations, diseases will in time show themselves—from the inevitable accumulation of poisonous materials, resulting from the growing infection of the soil, with its poisonous emanations, from the prolonged sojourn of a large number of men and animals—the camp, unless occupying a position of marked military importance, should be changed for a new situation at some convenient distance.

As the daily drills do not suffice to develop the physical organization of the soldier, he might be usefully employed upon public works, which may revert to his individual benefit—as the erection of batteries, the making of military roads, draining the sites of camps, etc. For months the roads in the vicinity of Manassas, where the Army of the Potomac were stationed, were nearly impassable, and transportation was so exceedingly difficult, that the army suffered severely for proper food. Had the troops

been ordered to work the roads instead of loitering for months in camp, the service would have been materially advanced.

The same want of forethought occurred around Charleston, where a large army was kept idle for months, while the laboring agricultural population were taken from their farms when they could be least spared, to erect works which the soldiers would gladly have done, the more especially if they could have received the extra pay allowed to these laborers. The provisions would have been more abundant, and soldiers could have been taught to labor, and by degrees inured to hard work, with all of its advantages, if they had been put in the trenches. In the Army of Virginia the soldiers were found not only always ready but willing to engage in such work as was required; and often, when *ennui* had taken possession of the camp, and homesickness threatened to break out as an epidemic, an order to erect works was always hailed with pleasure, and in twenty-four hours the entire camp would resume its accustomed gayety. Works were erected which we never expected to use, simply to keep the men employed, and make them contented and happy.

To enliven and relieve the toil and tedium of camp life, amusements are a very necessary portion of the day's duties; and it is found that lively music from the military bands every afternoon, will elate the men and remove monotony. Singing and music should be a portion of the military education, as offering an agreeable mode of passing the many idle hours of camp life which usually hang so heavily upon the soldier. Temporary gymnasia might be established, and gymnastic exercises should be encouraged as conducive to health, strength, agility, and address.

The manly play of ball, with its invigorating exercise, is the common amusement in a Confederate camp. In winter this gives place to mock-battles with snowballs, when regiments and brigades are marshalled against each other in amicable array, and take as much pride in attacking and in repelling assaults, and taking prisoners, as they have felt on the battle-field in taking and holding an enemy's position. Besides ball-playing, soldiers in camp amuse themselves with rolling ten-pins, shooting marbles, throwing quoits, racing, wrestling—any of which are preferable to card-playing, which, in camp, is inseparable from gambling. Cock-fighting is also an amusement of permanent camps, both officers and men in our volunteer army participating in this sport. Animal pets are very seldom met with in the army. As our troops find difficulty in supplying themselves with sufficient food, foraging for animals can not be thought of. This feeling of sympathy with the brute creation has been crushed by the hardships which have destroyed thousands of noble horses, the private property of officers and men, who have lost their favorite blooded pets from the gradual starvation attendant upon a permanent deficiency of food.

In the summer of 1859, during the Italian campaign, I was at Milan when a large body of French troops, returning from the bloody field of Solferino, arrived. In a few minutes their shelter-tents were pitched, under the shade of the trees on the broad boulevard which surrounds the city, and the soldiers were allowed to follow the bent of their own inclination. Card-playing, dominoes, fortune-telling, wrestling, and dancing to the discordant tunes of a hand-organ, or the sharp notes of an accordeon, appeared to be the order of the day.

Pets in various forms were commonly found among the troops, and these were guarded with scrupulous care. Many appeared to be adopted by the regiment as comrades, who have been associated together through many a hard-fought field and toilsome march. In the military hospitals of Milan—which were filled with the wounded, from its very near proximity to the battle-field and railroad facilities for transportation—it was not unusual to see a soldier, nearly exhausted from the tedious dressing of a frightful wound, when he had passed from the hands of the surgeon, take from his bosom a little sparrow, and from the cheerful chirp of this little bird appear to derive much consolation.

Not the least attractive incident connected with the triumphal march of Napoleon's Italian army through Paris, in August, 1859, was the pets accompanying these brave heroes. Here would be seen a goat, evidently proud of its position, marching with military step at the head of a column of ferocious Zouaves—going through the halt and advance by word of command, looking neither to the right or left, as if the success of the day depended upon its military deportment. Here, a regimental dog would show the pleasure with which he participated in this great occasion, while the caresses of the company, and the pleasant faces with which his presence would always be recognized, show the appreciation of his companionship. These little incidents are introduced to show the longing of all men for objects of affection, and also how many a tedious and otherwise unbearable hour in camp life is pleasantly spent in fostering those fine feelings of the human heart which keep soldiers, accustomed to blood, from becoming degraded and brutal.

CHAPTER II.

HOSPITALS, REGIMENTAL AND GENERAL — HOSPITAL TENTS, WITH EQUIPMENT — NUMBER OF ATTENDANTS ALLOWED — DUTIES OF SURGEON IN CHARGE OF A GENERAL HOSPITAL — OF DIVISION SURGEON — ASSISTANT SURGEON — APOTHECARY — HOSPITAL STEWARD — WARD-MASTER — NURSES — MATRONS — LAUNDRESSES — PATIENTS — CLEANSING OF HOSPITALS — CARE NECESSARY IN PREVENTING INFECTION — VALUE OF FUMIGATION — FEMALE ATTENDANTS — HOSPITAL DIET, ETC.

The accommodations for the sick form a very important department in the economy of an army, and, as a rule, are never sufficiently ample. With every body of troops in the field there are two kinds of hospitals—the regimental and the general. With regular armies there should always be a third—the convalescent hospital—situated in some salubrious, rural location, where convalescents, by inhaling pure air, and enjoying the pleasures of country life, can rapidly rebuild their shattered constitutions.

For the army in Virginia, during the summer and autumn of 1861, convalescent hospitals were established at points well adapted for the purpose, and were of essential benefit. The Virginia springs are known to all the world; at such places of resort every convenience exists for accommodating large numbers of visitors. At some of these watering-places the hotels and numerous cottages were converted into extensive hospitals, where convalescents from measles and typhoid-fever could use the mineral waters, enjoy the fine scenery, and recruit rapidly.

The REGIMENTAL HOSPITAL is usually under tents when in the field, if a suitable building in the immediate vicinity of the encampment can not be obtained. According to army regulations, the tents used as hospitals in the Confederate service should be fourteen feet in length, fifteen feet wide, and eleven feet high in the centre, with a wall four and a half feet, and a "fly" of appropriate size. The ridge-pole is made in two sections, measuring fourteen feet when joined. On one end of the tent is a lapel, which admits of two or more tents being joined or thrown into one, with a continuous covering or roof; such a tent accommodates, comfortably, from eight to ten patients. The following is the allowance of tents for the sick, their attendants, and hospital supplies—being accommodation for ten per cent. of the command:

COMMANDS.	HOSPITAL TENTS.	SIBLEY TENTS.	COMMON TENTS.
For one company.....	..	1	1
For three companies...	1	1	1
For five companies	2	1	1
For seven companies..	2	1	1
For ten companies	3	1	1

Owing to the sparcity of manufactories and the stringency of the blockade, tents have always been scarce in our army from the very commencement of our troubles. At sundry times we have been compelled, in our sudden change of position, and from insufficient transportation, to destroy our tent equipage to prevent their falling into the hands of the enemy. Having no reserve supply from which to draw, our army has, at such times, not only been compelled to live without tents, but the hospital supply has been materially curtailed. Rarely has a regiment more

than two walled tents to accommodate its sick, and much more frequently but one walled tent and one fly. On this account, only those cases which promise to be transient indispositions or acute diseases are retained for treatment in the regimental hospitals. They must always be considered but temporary structures, to be moved with the army, and to be broken up at an hour's notice. They should never, therefore, be encumbered with chronic cases, nor should they ever be permitted to be crowded. As soon as a case threatens to remain longer than a few days in hospital, it should be transferred to the general hospital for treatment.

To ensure a comfortable abode for the sick, the site of the regimental hospital should be selected with much care—the dryest spot in the camp should be chosen, and the tent well ditched, to give thorough drainage. The floor of the tent should be carpeted with oil floor-cloth or painted canvas, which will protect the sick from the emanations from the soil, and will prevent the soil from imbibing animal effluvia, at the same time keeping out all moisture, which is so deleterious to those lying upon the ground. This painted cloth strictly belongs to the hospital tent, and, as an essential part, should not be overlooked. A certain number of bedsacks also belong to the hospital. When these are filled with straw, they make a much more comfortable bed than straw thrown in heaps, which is the common mode of treating the sick in the field. There is much comfort in appearances, and these beds add much to the neatness as well as cleanliness of the tent. The beds are arranged on either side of the tent, with the heads turned toward the wall. Could the beds be elevated upon boards for six or twelve inches, they would place

the sick in a purer atmosphere than when lying on the floor, where the heavy, deleterious gases of expiration collect. In good weather, ventilation of these tents should always be insisted upon.

The straw should be changed as often as possible, even twice a week, if it can be procured; while, if the patient can get up, the bed should be well beaten and thoroughly aired daily.

It often occurred, in the medical experience of the Confederate service, that straw could not be procured—the inmates of the regimental hospital being compelled to lie directly upon the ground, which was, at times, damp, and even muddy, with no india-rubber cloths to protect them, and often without blankets to cover them. The suffering from the want of these necessary articles has been very great, and yet the men, in the beginning of the war, would prefer remaining in camp when sick, rather than enter the general hospitals, against which they had the strongest antipathy.

Personal cleanliness of the patient is as important as that of the tent. Ablutions should be freely used, although it may not be possible frequently to change the underclothing. Whenever the condition of the patients permit, the tent should be moved once a week, if it be only a few yards from its former position, so as to enclose a fresh piece of soil not contaminated with animal exhalations. This change of location is particularly required whenever any of the low grades of contagious diseases appear within its walls, or cases under treatment take on an asthænic character.

The hospital is allowed a certain number of attendants, to attend to the commissary and medical duties of the establishment. Each company has one steward, one nurse, and one cook; for each additional company,

one nurse is added; and, for commands of over five companies, one additional cook, if required. As a rule, one nurse is taken from the ranks for every ten men sick in regimental hospital. When there are but few cases under treatment, the supernumerary nurses and cooks are returned to the ranks. The surgeon is general superintendent of the hospital. Under his direction the steward, who, in the Provisional Army of the Confederacy, is usually a physician taken from the ranks, takes care of the hospital stores and supplies, and sees that the nurses and cooks perform properly their respective duties, and acts as medical dispenser and apothecary to the regimental hospital. If intelligent, he can readily be entrusted with prescribing for mild cases of disease, and thus relieve the surgeon of much trouble.

Not the least important personage in the hospital organization is the sentinel who guards the door, and sees that neither ingress nor egress is permitted, except upon orders from the surgeon. It is only in this way that patients can be prevented from committing imprudences which may cost them their lives. This guard should be constantly furnished to the hospital, and the surgeon is to signify to the commanding officer of the regiment the particular orders which he wishes to be given to the non-commissioned officer commanding it, and to the sentries.

Those treated in a tent hospital always convalesce much more rapidly than those collected together in a large hospital building, where, in proportion to the magnitude of the establishment and number of patients, we find the convalescence of the sick prolonged, the number of deaths increased, and the germs of contagious diseases developed. In concentrating a number of sick under one roof, although

many facilities for treating them are gained. yet the laws of hygiene will be, to a certain extent. unavoidably violated. Yet, from the very transient nature of regimental hospitals, more permanent institutions for the sick must necessarily be established.

General hospitals are usually located in some town or city contiguous to the army; or, should such locations be too distant, without facilities of transportation, buildings are taken possession of, or erected, near the military position, to be used as a general hospital. The organization of this, with its surgical staff, its stewards, ward-masters, and nurses, is upon a much larger scale than in the regimental hospital.

Early in the war, when our large and increasing army was undergoing acclimation, with thousands of sick, extensive general hospitals were required for immediate use, with no time allowed for the erection of proper buildings. The medical department was compelled to use factories, storehouses, hotels, colleges, or such large buildings as could be found contiguous to the position of our armies. In Richmond alone, numerous buildings, to accommodate nearly thirty thousand patients, were fitted up as hospitals. The same course was pursued elsewhere. At the present time, however, such temporary hospitals have, to a great extent, been replaced by newly-erected buildings, specially arranged for the convenience of the sick. The general plan of organization which appears to meet with most approval, allows of the concentration of a large number of sick under one supervision—the general hospitals recently constructed numbering from one thousand to five thousand beds. The advantages accruing from this arrangement are the greater facilities for treating the sick, an increase of comforts, with the great advantage

of sustaining a rigid military discipline, the greater readiness with which discharged soldiers are returned to duty, a more perfect organization, with a more judicious division of labor, without increasing commensurately the expenses of the institution, or requiring *pro rata* so many officers; and last, but not least, of rather diminishing the mortuary list or percentage of deaths.

The general plan upon which an institution of this kind is now established, is by erecting a number of one-story houses, about eighty feet long by thirty feet wide, well ventilated by means of slatted cupolas. Such buildings will each accommodate comfortably from forty to fifty patients, and are multiplied so as to accommodate from one thousand to five thousand patients. The concentration of so many buildings forms a village, with regularly laid out streets, those running in one direction being one hundred feet wide, while the cross streets are fifty feet in width. Each house being surrounded by streets, ensures thorough ventilation, and prevents over-crowding. In such a general hospital there are many divisions, each comprising about five hundred beds, and each being a perfect hospital within itself, with all offices necessary for successfully carrying on such an establishment, viz: kitchens, laundries, mess-rooms, baggage-room, linen-room, store-room, and guard-room. For the general use of all the divisions, are a bakery; a guard-house or prison for enforcing obedience; a chapel, in which service is daily held; bath-house, with hot, steam, cold, shower, and plunge baths; operating room, with dead-house; offices and houses for officers and employees; stables, and privies—the latter being distinct buildings for privates, non-commissioned officers, officers, and matrons.

Ordinarily, the following hospital attendants are allowed: a hospital steward, acting as mess steward; a hospital steward, acting as apothecary; a ward-master for every one hundred patients; two chief matrons; two assistant matrons; two ward matrons to each one hundred patients; one nurse to every ten patients—but should this number be found not sufficient, the government allows the employment of as many as are necessary for the careful nursing of the sick; a laundress for every twenty patients, and a cook for every thirty. In the large general hospitals each division of the hospital is presided over by a surgeon, who has a number of assistant surgeons under him—one to every seventy patients. Besides the number of employees enumerated above, there is a steward, who looks after the servants; a baggage-master, and an apothecary's clerk; and the surgeon, who is in charge of the entire establishment, is allowed one or more clerks for office duty. A military guard completes the staff of a general hospital.

The following are the duties assigned to each of these officers, and for the proper performance of which he is held strictly responsible by the surgeon, who is the administrating officer in charge of the institution.

The surgeon-in-chief, who is in charge of a large general hospital, is the responsible head of such an institution, and is constituted commander of such a post. It is his duty to define the duties of all officers attached to the institution, and see that all of the regulations of the hospital are rigidly enforced. He receives and enforces all official orders, approves all requisitions, endorses all certificates for furloughs or discharges given by his subordinate medical officers, takes charge of the hospital fund and attends to its

judicious disbursement, and keeps up a continued surveillance over all departments of the establishment, inspecting at such irregular times when he may be least looked for. His time is so absorbed in administering the affairs of the hospital, examining books, etc., that he can pay but little attention to the special care of the sick; and except in the capacity of a consulting and operating surgeon, and president of the examining board, composed of his division surgeons and himself, leaves the treatment of the patients to his division surgeons and his staff of assistants.

The division surgeon, who has charge of one of the divisions of the general hospital, is held responsible by the chief surgeon for the proper enforcement of all the rules and regulations of the hospital in his respective division, obeying all orders emanating from his chief. He inspects every department of his division daily, sees that all employees attend to their respective duties, and renders a daily morning report to the chief surgeon, with a copy of the daily register for his division. He appoints a medical officer of the day from his staff of assistants, whose duty it is to attend to all urgent calls of the sick in the division, during the twenty-four hours that he is on guard. He grants permits to patients to leave the hospital; approves requisitions of the hospital steward; makes out hospital pay-rolls, and a monthly report of sick and wounded in his division; keeps copies of all requisitions, quarterly reports, and also copies of all orders and letters; and files all applications for furlough, detail, transfer, and discharge, for the action of the examining board. Although he usually takes no ward himself, he visits daily all of the serious cases in his division, accompanied by the assistant in charge of such patients, and, with the chief surgeon, per-

forms most of the operations required in his division. The division surgeons, with the chief surgeon as president, constitute a board of examiners, whose duty it is to investigate the cases of all applicants for transfer, detail, furlough, or discharge.

Assistant surgeons are the general practitioners of the hospital, and are expected to assist the chief surgeon and division surgeon in enforcing rigidly the rules of the hospital, obeying all orders emanating from their division surgeon. It is their duty to visit their patients at least twice daily, and as much oftener as the serious character of cases may require. They must write each prescription in full, including diet, in the prescription and diet book, giving the name of the patient, and number of his bed and ward in every case, and will see that their directions are strictly carried out. In prescribing alcoholic stimuli of any kind, they will specify the quantity which each patient should receive, with directions in full for its administration. In prescribing it for themselves or any hospital attendant, they must certify that it is for medicinal purposes, and that it is necessary for the treatment of the case for which it is prescribed. They will report daily, by eleven o'clock, to their division surgeon, all deaths, desertions, convalescents fit for duty with their commands, or those for police duty; the number of vacant beds in their ward, giving the numbers of each; and also a weekly report (every Monday), giving the name, rank, company, regiment, division, ward, bed, and disease of each patient under their charge. They will write and file with the division surgeon, for the action of the examining board, and not commit to the patients themselves, recommendations for furloughs, transfers, or discharges, stating in each the regiment, company,

bed, ward, and disease of patient, and post-office address, as well as railroad depot nearest to their destination, and notify the applicant when and where to appear. In no case will they deliver a paper to an applicant that requires action of a superior officer. They will write upon the bed-ticket the diagnosis of each patient's disease.

One assistant surgeon from each division of the hospital will be detailed daily as officer of the day. He will visit and prescribe for any patient in the division who may require his services, during the day or night while he is on duty, writing the prescription for such in the prescription and diet book of the ward. He will inspect each ward in the division every six hours, and will, in the absence of the division surgeon, exercise all the functions pertaining to that officer. When relieved from duty he will make a report in full to the division surgeon, of everything that may have transpired in the division, giving the hours of his different visits to the wards, etc. When not on duty in the wards he will remain in the office of the division surgeon, so as to be readily found in case he is wanted.

It is the duty of the *clerks* to keep the books, and to perform all such writing as the surgeons may direct. In all large general hospitals a clerk is assigned the duty of baggage-master, whose duty it is to receive the baggage of all patients, properly labelled and delivered to him by the ward-master or head nurse of each ward, to whom he will give a receipt for the same, delivering the baggage to the same only upon the return of the receipt. The baggage-room has its shelves divided into as many compartments as there are beds in the hospital, into which are placed, in alphabetical order, the property

of the patients, the baggage always being labelled with name of patient, rank, company, regiment, division, ward, bed, and post-office. It is the duty of the baggage-master to see to the safety of the articles entrusted to his care, and, for their better protection, he occupies quarters adjacent to the baggage-room.

The hospital stewards, receiving commissions from the Secretary of War after an approved examination before an examining board, are entitled to obedience from all enlisted men in hospitals—both patients, ward-masters, and employees—and he, in turn, owes prompt obedience to the commands of his surgeon. He should be honest, temperate, intelligent; writing legibly and correctly, with some knowledge of book-keeping, pharmacy, and minor surgery. In a small hospital the hospital steward has, under the surgeon, a general superintendence of hospital; regulates its police, discipline, ventilation, lighting, and warming; attends to provision returns; carries out the surgeon's instructions as to the management of the hospital fund; makes purchases for the hospital; takes care of hospital stores; sees that the cooking is properly performed; takes charge of the dispensary, puts up prescriptions, as well as renders assistance in dressing of wounds; sees that the hospital property is duly cared for—and, in fact, is responsible to the surgeon for the general administration of the institution.

In hospitals of one hundred beds and upwards, these duties become so onerous that two hospital stewards are assigned to duty in the same institution—one as apothecary, to attend to the dispensary and the dispensing of medicine; the other as mess steward, to look after the administrative duties of the hospital. When hospitals are as large as many such establishments now in full operation attached to our

army, comprising from one thousand to four thousand beds, they require the services of several hospital stewards.

To each division of such a general hospital there are usually two or more commissioned hospital stewards—one, and sometimes two, acting as druggists, one as mess steward, to look after hospital property and the attendants, and one as clerk. It is the duty of the druggist to put up only such prescriptions as are written out by a medical officer of the division to which he is attached, and will issue nothing unless so directed. He will use, on all occasions, the scales and measures in the compounding of medicines, keeping all apparatus about the dispensary scrupulously clean, and everything in order. He will be held responsible by his division surgeon for the proper care and dispensation of all medical supplies committed to his charge. Five days before the end of each month he will furnish the division surgeon with a statement of the quantity of all medical supplies on hand, and the quantities of such as will be required for the ensuing month. None but such as are authorized will be allowed to enter the dispensary.

It is the duty of the clerk to keep a register of the daily admission of patients into the hospital, to make out a morning and monthly report, to fill out hospital pay-rolls, and to perform any other duty in writing for the hospital directed by the surgeon.

The mess steward takes care of the hospital stores and supplies, receives and distributes rations, prepares provision returns, keeps a record of all the transactions of his department, and renders a written report to the surgeon at the end of every month. He takes charge of the valuable effects of sick and deceased patients, labelling and keeping a proper regis-

ter of the same; visits daily, and reports the condition of the sinks of his division to the sergeant of the police guard; ascertains who are present at roll-call at sunrise, sunset, and *tattoo*, and reports absentees. The kitchen and cooks are placed immediately under his supervision, and he is held responsible for the cleanliness of the kitchen, as well as for the proper preparation of the food. He also prepares and issues to each patient a meal-ticket, receiving the same at the door when the patients enter the mess-hall; at the same time supplies them each with a knife, fork, and spoon, which each must return to the steward as he leaves the hall after the meal. When a steward is not specially assigned to the duty of looking after hospital property and supervising the servants, the mess steward must consider this as a portion of his duties. He is also expected to visit every portion of the establishment three times every day, the last visit being after *taps*, and see that everything is kept in perfect order. In his office, in a conspicuous place, is hung up a table containing the names of all the attendants of the institution, with a list of their respective duties.

In every hospital, and in each division of an extensive general hospital, there is a general *ward-master*, whose duty it is to commence the day by having all the wards and the grounds surrounding the buildings swept, and the dirt collected in piles ready for removal, and also to see that no filth accumulates in the chambers or buckets about the wards. He takes charge of the effects of each patient upon admission, has the same properly labelled with the patient's name, rank, company, and regiment, together with the ward and number of his bed, and has the same properly registered in a book kept for that purpose, and delivered to the

baggage-master to be stored away in the baggage-room. When a patient leaves the hospital, all of his effects are restored to him by the ward-master. Should the patient be discharged from the army, it is the duty of the ward-master to retain possession of all government property which the patient, as a soldier, had the use of, and when such accumulates, to turn over the same to those officers who issue them. All money and jewelry he delivers to the surgeon for safe keeping. He receives from the steward the furniture, bedding, cooking utensils, etc., for use, keeps a record of them (Form 10, Med. Reg.), and a statement of how distributed to the wards and kitchens, and once a week renders a written inventory of the same to the steward, with a statement of any loss or damage, returning to him such as are not required for use, and receiving from him such articles as are necessary for the ensuing week.

The ward-master distributes to each chief nurse in a ward such articles, accompanied by an inventory, as the comfort of the sick may require, and for which those receiving are held strictly responsible. The ward-master reports daily the number of vacant beds in the wards; takes charge of all soldiers returning to their regiments at the clerk's office, and conducts them to the military guard. When a patient dies, he will pin on his breast, previous to committing the body to the "dead-house," his name, rank, regiment, company, number of bed, ward, and division in which he died, and report the same to the division surgeon. They are not allowed to receive a patient in their wards unless accompanied by a permit from the division surgeon. These permits, together with orders for transferring patients from beds or wards to others, will be carefully preserved as vouchers.

In general hospitals one nurse is allowed to every ten patients; and where the wards contain many beds, a head nurse presides over each ward, who is held responsible, by the ward-master, for the order, discipline, and cleanliness of the ward. It is his duty to see that the beds are kept constantly arranged—all chamber utensils cleaned immediately after being used, ward properly kept, meals to patients confined to bed furnished at proper hours; that the medicines are sent for to the dispensary, received from the druggist, and arranged in a closet prepared expressly for this purpose in each ward, in which the medicine belonging to each patient is placed at a number corresponding to the bed occupied by the patient; that at the proper time the medicines are administered to the patients as directed by the medical officers; that the patients obtain such diet as may be prescribed, and no other; that the ward is properly ventilated, and sufficiently warmed in winter, and that the police regulations established by the surgeon in charge are scrupulously complied with. He will maintain order and discipline among attendants and patients, and will report every neglect of duty and disobedience of orders. He will allow no patient to keep arms, accoutrements, knapsacks, or packages in his ward, nor to introduce any fruits or improper diet.

When the surgeon visits the ward, it is the duty of the head nurse to accompany him from bed to bed, with slate or memorandum-book, in which he will note all directions of the surgeon as to the administration of medicine, diet, etc., and is held responsible for their proper fulfilment. He allows no patient to enter his ward without a bed-ticket from the surgeon, which he immediately deposits in its proper receptacle at the head of the bed to be occupied. He will promptly

report the departure of patients from his ward on furlough, discharge, desertion, or unauthorized absentees, delivering the bed-ticket of the same himself to the clerk—never allowing patients to do so. He conducts all patients returning to their regiments to the clerk's office, after having procured their baggage, and there delivers them to the charge of the ward-master. He receives and receipts for clothing to be washed, to the patients and attendants of their respective beds, turns them over to the matron in charge of the laundry, and takes a receipt for them. He defines the duties of his assistants. As these duties are responsible and important, the chief nurse of a ward should be sober, honest, industrious, intelligent, and take an interest in his duties.

In wards of over twenty beds, the head nurse exercises chiefly supervision and general responsibility. The beds are divided equally among the remaining nurses, each of whom is held responsible for all that pertains to such as are put under his care. He will insist that convalescents, who are able, make up their beds immediately after rising in the morning, and will himself arrange the beds of such as are unable to do it for themselves. The assistants are held responsible for the cleanliness of their patients—bathing, washing the face and hands, and combing the hair of such as are unable to do this for themselves. In every instance, where a bed-pan or chamber is used, the nurse must immediately remove it from the ward. When the personal or bedclothes of a patient are soiled, they should also be changed without delay; and, when the character of the case requires it, the bedclothing should be protected by gutta-percha cloth or oiled silk.

It is the duty of the assistant to accompany the

surgeon while visiting the patients under his charge, and either take down upon a memorandum-book the directions of the surgeon as regards the diet, administration of medicines, or the general care of each patient, or have free access to the memorandum-book of the chief nurse. For such patients as are confined to bed he will obtain the prescribed diet, and will see that all who are able will eat in the mess-hall. All medicines prescribed the nurse will administer with his own hands; and to facilitate the administration at regular periods, it is customary in some general hospitals to mark the day by adopting ship time—sounding the bell at every half-hour. For instance, commencing at mid-day, the bell is struck once for half-past twelve o'clock, twice for one o'clock, three times for half-past one, and so on until it is struck eight times for four o'clock, when the series is recommenced. Besides such special duties, the general duties of the ward—as sweeping, scrubbing, cleaning of windows, management of fires, cleansing of water-closets, etc., bringing of meals to the sick who are unable to visit the mess-hall, etc.,—are distributed among the assistants, the head nurse making the assignments.

One night-nurse is assigned to each ward, and for each division a head nurse, whose duty it is to visit every ward every hour in the night, to inspect the fires and lights, and see that the nurses attend to their respective duties.

The arrangement which is adopted in some of our large general hospitals is to have one general ward-master for a division of the hospital; one section ward-master to a section of four wards, or about one hundred and twenty beds; one subward-master or head nurse to each ward, with two nurses as assistants—

these being usually negroes—one of whom, with the subward-master, is on duty every day in each ward of thirty beds. At night one nurse is left in each ward, a head nurse to each section, and a ward-master to each division, so that the nurses are on duty for twelve hours and off for a similar period, while the other officers are on duty all day, and every fourth night alternating. Night-nurses are never called upon to assist in the hospital in the day.

One chief matron, with an assistant, is put in charge of the laundry and linen-room. Her duty consists in receiving from the nurses the soiled clothes from their respective wards, both of the patients and from beds, marking and mending these before they are sent into the laundry, and count out daily to the laundresses the number of pieces to be washed, requiring the same number to be returned to her linen-room; to distribute clean clothes, both for beds and patients, to the wards, and report to the surgeon such laundresses as may fail to comply with her regulations, or may extort money from soldiers for washing. She keeps a book, in which is entered all receipts and issues of both soiled and clean clothes from patients, as well as bed-linen, giving receipts, enumerating articles, to laundresses and nurses for the same.

One chief matron, with an assistant, takes charge of the pantry, kitchen, and mess-room. She is responsible to the surgeon for the proper preparation of all diet, and for the cleanliness of her department. She provides suitable diet and delicacies for all the ill patients, as directed by medical officers, and takes charge of all stimuli required by the sick.

An important officer in every general hospital is the sergeant of the guard, who is responsible for the orderly conduct of all inmates of the institution. It is

his duty to prevent the peace and comfort of the sick from being disturbed by noises in the precincts of the hospital. He sees that the hospital is properly guarded, day and night; that no patient, attendant, or sub-officer leave the institution without a proper written permission from the surgeon in charge; and that the police regulations for streets and sinks are daily enforced. He takes charge of, and conducts under guard, discharged soldiers returning to their regiments, to barracks, or railroad, as he may be directed. He executes the rules and regulations pertaining to the guard-house, and makes a daily report to the surgeon in charge of the hospital. The guard of the hospital mess with the convalescents, and their rations are drawn upon the provision returns of the hospital. When a detachment from the post guard or provost guard can not be obtained for a hospital, a guard can be formed from such soldiers as the examining board recommend for light duty, and as unfit for active field service.

Patients, upon arrival, will immediately report to the central register office, to be assigned quarters. They will turn over all arms, accoutrements, baggage, etc., etc., to the baggage-master, receiving a check for the same. They will not be allowed to smoke in the wards, nor spit upon the floors or walls, nor commit nuisances of any kind. They will take their medicines as directed, and abstain from the use of fruits and diet forbidden by the surgeon. They will report themselves to the clerk's office to receive bed-tickets, which they will present to the head nurse upon entering the ward to which they have been assigned. They are prohibited from loafing about the clerk's office, drug-store, or kitchen. All applications for transfers, furloughs, and discharges must be made to

the assistant surgeon of their wards, which will be properly forwarded—and, if granted, be returned to them at their wards. They will obey the steward, ward-master, nurses, and all officers of the hospital; and, when convalescent and fit for light duty, assist in policing the hospital, under the direction of the ward-master or commandant of the guard.

In the general discipline of a hospital, the surgeon in charge is commandant of the post or institution, and exacts implicit obedience from every inmate of the establishment, and he is expected to conduct the institution in accordance with the rules of strict military discipline. As the responsibility of the entire hospital rests solely upon the surgeon in charge—the government recognizes no other chief—he must, in turn, hold his assistants to a strict accountability; and they, in turn, their subordinates—so that every *attaché* of the establishment is held strictly responsible for everything in his keeping.

In all well-regulated military hospitals the following regular order of duties is observed: *Reveille* is called at five, A. M., in summer, and six, A. M., in winter; and, fifteen minutes later, the morning roll is called for all the attendants, who immediately afterward commence the general cleansing of the hospital. Such convalescents as are able, after washing and dressing themselves—wash-rooms being provided in all hospitals—make up their own beds, and assist in putting their portion of the ward in order. At seven, A. M., in summer, and at eight, A. M., in winter, is the hour for breakfast, when all convalescents, and such attendants as are not required in the wards, assemble and march to the mess-room. For such patients as are unable to leave the ward, breakfast is brought by the nurses, and those who can not feed themselves are fed.

The attendants in the wards take their meals immediately after it is served to the patients.

The chief nurse now sees that the wards are cleansed and put in thorough order for the surgeon's call, which is at eight in summer, and nine in winter. At these hours, when the call is sounded, each patient repairs to his bed, where he remains until the visit is completed, while each medical officer commences the morning visit to the wards under his charge. The medical officer examines each patient carefully, and the prescription and diet for each is entered in a book kept for that purpose. After the visit, these books are carried to the dispensary, where the medicines are prepared, and duly labelled with ward, bed, name of patient, date of prescription, dose, and time of administration. At the same time the steward copies off the diet for convalescents, and also the prescribed diet for the sick, which list is given to the chief matron of the cooking department to be prepared.

Every part of the hospital is swept thoroughly every morning, and such portions in which dirt accumulates are reswept as frequently during the day as cleanliness requires. The kitchen should be kept as clean as the wards, and besides the early morning sweeping, should be swept out after every meal. The grounds around the hospital, with the walks, should also be swept every morning. After the morning use of the wash-room, this is also put in order, and kept so during the day. The privies, after being thoroughly scrubbed every morning, are put in charge of an attendant or guard, who inspects them after their use by every patient, in order to fix the neglect of cleanliness upon the guilty party. These, with all other portions of the establishment, are whitewashed as

often as neatness requires. After the surgeon's morning visit to the wards, should they require it, the soiled spots upon the floors are washed and rapidly dried, using but little water in the cleansing, and the entire floor is well scrubbed with dry sand, and swept. This dry-scrubbing is found far preferable to the flooding of the wards with water, which causes so much annoyance and detriment to the patients. During the intervals of attendance upon the sick, the nurses and attendants in the wards will find ample employment in keeping the floors, walls, and windows of the wards clean. Bed-sacks are refilled with straw at least once a month, at which time the ticking should be washed in boiling water.

At one, P. M., the dinner-hour, convalescents are again marched to the mess-room, and food supplied to those detained in the wards. At five, P. M., the surgeon's afternoon call, the patients are visited in the wards as in the morning. Supper is served at six, P. M. At eight o'clock *tattoo* is beat, at which time the night-watches are set in the wards, and patients prepare for retiring. At nine o'clock (*taps*) all unnecessary lights are extinguished, and all patients must be in bed. The steward now pays his third visit to the wards, to see that everything is in order for the night. During the night the officer of the day visits frequently the wards. Should any patients be absent from their beds, the nurse reports the fact to the ward-master, who embodies it in his morning report. On one day of every week, usually on Sunday, when the attending surgeons have completed their visits, usually between eleven and twelve o'clock, the chief surgeon makes a general inspection. The steward goes through the hospital immediately before the surgeon's visit, to see that everything is in

order. At this inspection nothing, either in the wards or the patients, should escape the observation of the surgeon Accompanied by his staff, he should visit every portion of his establishment—wards, kitchen, store-room, baggage room, dispensary, bath-room, and privies. During this inspection of the wards, each patient remains at his bed.

With some modifications, the following will comprise a code of regulations, which is drawn up by the surgeon, to be printed, and posted in each ward, and other conspicuous places in the hospital:

CODE OF REGULATIONS.

1. No officer, attendant, or patient is allowed to leave the hospital without a written permission from the surgeon. The pass will be shown to the sentinel on post, on issuing from the institution, and given to him on the return of the bearer.

2. Profane or obscene language, and disorderly conduct of any kind is strictly forbidden; and no spitting on the floor, nor defacing in any way the walls, will be allowed. Nor will smoking be allowed in the wards, unless by special permission of the surgeon.

3. No patient shall be admitted into a division without a ticket of admission from the surgeon in charge; nor into a ward without a ticket from the division surgeon; nor returned to duty until reported to the division surgeon. Nor shall transfers of patients from one bed or ward to another be allowed, unless ordered by the division surgeon.

4. The beds are to be made up every morning by attendants, or oftener, if necessary. Convalescents who are able must make up their own beds.

5. No patient will occupy his bed without undressing.

6. Every patient, who is able, will wash his face and hands at least every morning, and keep the rest of his body clean. Those unable, will be attended to by the nurses. Every patient, whose condition does not forbid it, will take a bath upon admission.

7. During the morning visit of the surgeon, every patient and nurse must be in the ward, and patients who are able will stand at the side of their beds until examined by the surgeon.

8. All patients must be in bed at nine o'clock, when all lights are extinguished, unless otherwise directed, except in the office, and one in each ward, which will be lowered. All talking in the ward is prohibited after this hour.

9. No patient or nurse will be allowed to enter the office, dispensary, or kitchen, unless on business.

10. No provisions, no spirituous liquors of any kind, shall be brought within the hospital without the permission of the medical officer of the day, nor will friends or relatives of the patients be allowed to distribute such articles without permission of the surgeon of the ward.

11. Patients will give prompt obedience to the steward, ward-master, and nurses, in all lawful commands. Any infractions of discipline, disobedience of orders, drunkenness, or disorderly conduct, will be promptly punished.

12. Patients and attendants are requested to report promptly to the division surgeon any neglect of duty on the part of any attendant or officer, deficiency of diet, loss of clothing sent to the laundry, etc. In case the division surgeon does not give redress, the matter will (when there is just ground of appeal) be laid before the surgeon in charge for final action.

13. All official communications must be sent through the proper channel.

Upon the arrival of a patient at a general hospital, he is at once carried to the office, where his order for admission is taken and filed away, as also his descriptive list, so that the surgeon in charge may endorse upon it all payments, stoppages, and issues of clothing which may be made to him while in the hospital. Should the patient be ordered to hospital without this descriptive list, it will be the duty of the clerk to obtain one from the commander of the company to which the patient belongs. His name, rank, company, regiment, etc., etc., having been carefully registered, his effects are turned over to a ward-master, who has them duly entered upon the book kept for this purpose by the baggage-master, and put away in the baggage-room. Any money and other valuables which he may have are given to the steward or surgeon for safe-keeping, and a receipt given to the patient for the same. Such items are also duly entered in a book kept for that purpose. He should then be carried to the bath-room, unless his condition forbids it, and finally is received into a ward where a bed has been assigned him.

The following form of bed-ticket is placed in a convenient frame, at each bed, and forms a succinct synopsis of the history of each patient. When filed, these comprise a duplicate register:

GENERAL HOSPITAL.

Division ———, Ward ———, Bed ———.
Name ———, Age ———.
Residence or post-office ———.
Regiment ———, Company ———.
Previous occupation ———.
Admitted ———.
Where from ———, By whose order ———.

Disease ———, Date of commencement ———.
Seat ———, Character of wound ———.
When ———, Where received ———.
Operation ———.
Date of ———, Result ———.
Supervening disease ———.
Final disposition ———, Date ———.
Remarks.

———, *Ward Surgeon.*

On the back of this bed-ticket may be placed a statement of the effects of the patient, as follows:

ARTICLES.	NOS.	ARTICLES.	NOS.
Knapsack...............		Boots or shoes..........	
Great-coat.............		Socks................	
Uniform-coat...........		Blanket........... ...	
Trousers...............		Money................	
Shirts.................		Arms.................	
Drawers................			

In leaving the hospital, the patient is turned over by the head nurse of the ward which he occupied, with his bed-ticket, to the ward-master, who conducts him to the clerk's office, where he obtains his descriptive list, endorsed by the surgeon, showing the state of his account, and also his discharge papers, and such valuables as he left in charge of the surgeon. If the patient is discharged from the army, it is the duty of the hospital surgeon to make out his final statement of pay and clothing. He is then conducted by the ward-master to the baggage-room, from which his effects are obtained, when he is turned over to the military guard, to be conducted to the rendezvous appointed for such as are ready to return to the army. This plan of keeping discharged patients under guard until

they are returned to their regimental commanders has been found necessary, on account of the general disposition of soldiers discharged from hospital to loiter for days, and sometimes for weeks, before rejoining their commands.

In every hospital, over-crowding is always to be guarded against; and, as a certain number of cubic feet are allowed each patient, hospital surgeons are instructed to have a statement of the cubic measure and capacity of each ward placed conspicuously in each, so that the inspector, at a glance, can see that this important regulation against crowding is observed. The number of cubic feet allowed each bed of a ward is eight hundred; but as height does not compensate for area—as all the dangerous gases stagnate in the lower strata, near the floor of the room—it would be better to allow each patient so many square feet, say eighty square feet, for each bed. For those who are sick with typhus-fever, or the severely wounded, twice this area, or at least one hundred square feet, will not be too much space, if it be desirable to prevent pyæmia, hospital gangrene, erysipelas, and other fatal complications, from showing themselves. Rooms with less than ten feet ceiling are not fit accommodation for the sick.

With a constant tendency to a poisoning of the atmosphere from imperfect ventilation, all precautions of cleanliness can not be too rigidly enforced. In the cleansing of hospitals, too frequent scouring is prejudicial to the sick, and is found to induce low forms of disease. In French hospitals, the wooden floors are waxed and rubbed daily, which avoids the excess of moisture in the atmosphere of a ward. In our military hospitals the floors are sanded and dry-scrubbed daily, only the very dirty spots being washed. Every ten days or a fortnight the entire floors are washed over.

Spittoons should be furnished to every bed, and the sick should be prohibited from spitting upon the floors. These spittoons should be cleansed daily, and newly sanded; and, when much used, the sand should be changed twice daily, or they may become offensive and injurious. All urinals, bed-pans, and chamber-pots should be emptied as soon as used, and never be allowed to remain soiled in the ward. The bunks in the hospital, after being in use for three or four weeks, should be taken out of the wards, well scoured, and exposed to the weather, before they are returned. As soon as a bed is vacated, if it has been in use more than ten or fifteen days, the straw should be burnt and the sack washed and refilled. Blankets should also be frequently changed and washed. Personal cleanliness is essential in a general hospital. If conveniences are at hand, the patient, upon admission, should be bathed and placed in clean clothes, and in a clean bed. The beds should always be kept in order, whether occupied or not, and should a patient leave it only for a few minutes, it should be put in order by the attending nurse while he is out of it.

Such a general hospital should, among other things, be liberally furnished with hospital clothing, which, in Confederate hospitals, consist only of shirts and drawers. In European general military hospitals the patient leaves everything behind him when he enters its wards. He receives a bath, and is dressed up in the hospital clothes; his own are washed and stored away, properly labelled by the ward-master. Should he be suffering under any contagious disease, as the itch, typhus fever, etc., his clothing, after being well washed in boiling water, are fumigated for twenty-four hours in a closed chamber or tent with chlorine gas. With itch patients, sulphur fumigations are substituted for chlorine.

The ward-master should never allow the wards of a hospital to be encumbered with the packages or accoutrements of the inmates, but all such should be stored away in a store-room, where a series of pigeon-holes, two feet square, are arranged, and numbered as are the beds, so that each inmate of the hospital has a square allotted to him wherein to deposit his private stores. Where the hospital is well organized, every article which the patient brings in is deposited in the store-room.

Whenever an infectious or contagious epidemic threatens to invade a hospital, the vigilance of the sanitary police of the institution should be redoubled, in order to remove or counteract those causes which might assist in producing or disseminating such disease. A thorough examination of the building should be made; all offal, of whatever character, should be removed as soon as discovered. This relates especially to the using of chamber utensils in the wards, which, under no circumstances, should be allowed to remain soiled. Cleanliness in every department must be enjoined. The diet of the patients should be improved in quality, and more liberally distributed; and wine, or some stimulating drink, should be given to convalescents, who should be examined daily, so that any irregularity in the functions of their digestive organs may be corrected. Free ventilation of the building, the frequent changing of bedding, avoidance of all crowding in the ward, and an increase in the number of cubic feet to each patient, the separation of convalescents, who should be sent away from the infected building, the early burial of the dead, both for its moral as well as hygienic benefit, are some of the many precautions which surgeons in charge of hospitals will adopt.

When any low form of disease makes its appearance in a ward, this portion of the building should be temporarily closed for the reception of patients, and should undergo a thorough cleansing and whitewashing. Heating the air contained within the closed room by means of stoves, so as to attain a high temperature, or fumigations with chlorine may, at times, be required to destroy the fomites causing the disease, and render the ward again habitable. This closing and general cleansing should also be adopted whenever a ward has been occupied for a length of time by those seriously injured, suffering with extensively suppurating wounds. Should any one enter at midnight a ward thus inhabited, the insufferable smell and the sensation of oppression from inhaling the atmosphere would at once explain the danger from low forms of infectious diseases, and the necessity for not only constant cleanliness and continued ventilation, but also for purifying the same at intervals.

Stromyer, in his Maxims of Military Surgery, based upon experience and observation during the Schleswig-Holstein war, states that such rooms should be thrown out of use for two weeks after every two months occupation. This he lays down as an important hospital regulation. Chemical disinfectants were not found useful by him as long as the rooms were occupied; the rooms must be vacated. *For occupied rooms, draughts of fresh air are the only good disinfectants;* and to obtain this end, without detriment to the sick, the windows should open near the ceiling, and the sashes should be so arranged that the upper one can be lowered, which admits fresh air without pouring a cold current directly upon the sick. The slight exposure to catarrhal affections is not to be considered, when compared to the danger of introducing infectious diseases, by per-

mitting a foul and unrenewed atmosphere to be inhaled by the wounded. It is owing to the advantages for ventilation that tents are so much better than wards for typhus and severely wounded patients, the more especially when wounds show a sloughing tendency. Pure air, continually renewed, is essential for the cure of typhus and hospital gangrene. Abundance of fresh air covers a multitude of inconveniences.

In the arrangement of a Confederate military hospital of recent construction, this general imperfection of ventilation is, to a great extent, obviated. The one-story frame building, with boards not fitting very closely together, and a permanent ventilator in the roof, creates continued interchanges of air, which enables the patients to live in a constantly renewed atmosphere. This will account, to a great extent, for the comparatively small mortuary percentage in the military hospital practice of the Confederate States—being an average of about four per cent.*

In the Crimean service, the French attached great importance to the fumigation of their wards. The surgeons of their immense military hospitals thought that they derived decided benefit from adopting the Turkish custom of fumigating with dried sage, which was burnt in the wards three times a day; in addition to the use of chlorine fumigations morning and evening.

A saucer of chloride of lime was also placed under the bed of each typhus patient. It is a question whether these fumigations act from the medicinal virtues which they possess, or upon hygienic princi-

* A consolidated report of the hospitals in the Department of Virginia, from September, 1862, to December, 1863, inclusive, prepared by Surgeon W. A. Carrington, Medical Director, gives total admitted, 293,165; deaths, 10,248.

ples. The European nations have such a dread of draughts, that a door or window is never left open, which induces the belief that they were intended to give light and not air.

This difficulty of ventilation through the windows, which are the proper media for it, is the common subject of complaint among the medical staff of hospitals. Stromyer had to enter into a regular compact with his German patients. He would only allow them to smoke provided they would keep the windows open, using this subterfuge to ventilate the wards. A celebrated English medical lecturer placed the value of fumigations in their true light, when he said: "*Fumigations are of essential importance; they make such an abominable smell that they compel you to open the windows.*" When these means are used, without affording the impure air means of escape, they only act as masks—disguising, by their strong odors, the offensive and injurious exhalations from the sick. They quiet the anxieties of the nurse, without in any way benefiting the patient.

It must never be forgotten that many symptoms which are said to belong to a disease, depend upon the circumstances under which it is contracted or treated, and many of these can with truth be accredited to bad ventilation; hence the different phases which diseases assume under treatment in hospitals when contrasted with cases in private practice. If such causes will produce disease (a fact with which every one is familiar), how much more likely are they to modify those already existing? Every physician of experience and observation has seen serious cases of fever, which threatened a fatal issue, commence to improve from the moment that the patient was changed from the room in which he had long been

lying, with its closed windows and musty smell, to a light, cheerful, well-ventilated chamber. This is always attributed to change of scene, while the true cause, change of air, is overlooked.

Typhus patients, and cases of hospital gangrene particularly, should always be treated in tents, and ample room be given to each. Over-crowding is certain to produce such a condition of the atmosphere as to heighten the mortality. It also becomes imperative upon those taking care of such infectious patients to breathe the air as little as they can; live out of the room or tent as much as possible, compatible with the proper attendance upon the sick.

Surgeons placed under such circumstances, in a badly-ventilated hospital, must take additional care of themselves. Personal cleanliness becomes a necessity; the liberal use of the bath, and the frequent changing of their clothing, will be found a wise sanitary precaution. Their diet should consist of simple and easily digested food, with *stimuli* in moderation. They should avoid all excesses, both in eating and drinking—as those addicted to intoxication and gormandizing are placed in the same category with the weak and poor, from which classes the mortuary tables of epidemics are chiefly made. In taking exercise in the open air, fatigue must be avoided. His mind must be free from all anxiety or personal fear of the disease. He should take a full proportion of sleep, and in the general care of his person should watch every indisposition, and correct derangements of the digestive system before they lead to more serious conditions.

The medical attendants in typhus hospitals, or in such as are infested with pyæmia, gangrene, etc., should frequently change places with those in charge of more

healthy institutions; otherwise, the permanent medical attendant, inhaling daily this poisoned atmosphere, will be sacrificed to an absence of a regular interchange of stations and duties.

In the best regulated hospitals each typhus case has two beds. Every twelve hours he is changed, and the bedding upon which he has been lying fumigated and well aired. The bed and body linen of such patients should also be changed daily. As typhus is known by its infecting nature and its easy transmission, the hospital wards can not be protected by too many hygienic regulations. When a hospital has become infected with typhus, pyæmia, or hospital gangrene, it is best to close it and turn out all patients. It would be much safer for the sick and wounded to stay in the streets or lie in the field, than be sent to such an infected establishment. His permit for admission is his death-warrant, while combating the elements would give him at least a chance for successful treatment. Any temporary, well-ventilated structure—a hut rudely made of rough boards—or a tent—would be infinitely preferable to gorgeous palaces with gilded chambers, in which Death sits in state to receive his victims.

In general hospitals the blessings of a woman's care, her ever-watchful eye and soothing words, her gentleness and patience, have added largely to the comforts of the sick. Florence Nightingale, when she made her disinterested offer to nurse the sick in the Crimea, could have little foreseen the new era dawning for suffering humanity, and the benefits which she was bestowing upon future generations.

It is woman's peculiar prerogative, as it is her earthly mission, to give comfort to those in distress; and when the English adopted the custom long prevalent

in France, to allow female nurses to minister to the wants of those suffering in military hospitals, the wounded felt that half their solicitude was removed. Now a Sister's care will bathe the sufferer's aching head, or offer him the cooling draught to allay his parched thirst; will sympathise with his pains, and give sweet consolation to his dejected spirit; and, by removing that overpowering weight of loneliness, by which the sick in hospital far from home and friends are oppressed, will often pave the road to speedy convalescence. A cheerful look, a kind word, a pleasant smile from one of these self-denying Sisters, has sent many a thrill of pleasure through a stricken soul. The surgeon sees, at his next visit, the fruit of this pleasantly-administered draught, which, perhaps, he blindly attributes to his own nauseous drugs.

The experience of Confederate hospitals, in recognizing the vast amount of good which female nurses accomplish, and the incalculable service which they are capable of performing, when judiciously selected and properly organized, is a sufficient reason why they should be attached to every hospital, and especially in times of war, when their many and peculiar services can not be dispensed with. To the surgeon, a good, kind, reliable nurse constitutes more than half the treatment of the sick. It is with the most serious cases that their advantages in nursing are best displayed. McLeod, who studied carefully woman's services in the Crimean hospitals, says: "A woman's services in a hospital are invaluable, if they were of no further use than to attend to the cooking and the linen departments; to supply 'extras' in the way of little comforts to the worst cases; to see that the medicines and wine ordered are administered at the appointed periods, and to prepare and provide suitable drinks.

"As to the employment of 'ladies,' I think they are altogether out of place in military hospitals, except as superintendents. As heads of departments, as organizers, as overlookers, 'officers' of the female corps, if you will, they can not be dispensed with; but for inferior posts, strong, active, respectable *paid* nurses, who have undergone a preliminary training in civil hospitals, should alone be employed. In camp hospitals, which, with an army in the field, are merely the temporary resting-places of the sick, men should alone be employed as nurses; but in the more fixed hospitals in the rear, the lady superintendents and under-nurses, should, in my opinion, always be added to the regular staff. Their attention should be limited to the bad cases, and they should have the entire control of the linen, medical comforts, and cooking.

"All cleaning should be done by men. There should be a lady superintendent over each division of the hospital, responsible to the surgeon as well as to her own lady chief. Then there should be a store of 'extras' under her charge, distributable on requisition from the medical attendant, and which depôt should be filled up to a certain quantity weekly, the Sister being held accountable for the contents. Wine and all extras should pass through her hands. She should be responsible for the due performance, by her female subordinates, of their duties, and have a right to interfere with the ward-master if the cleaning, etc., is not properly attended to by his male corps."

The material of which the Confederate army is composed differs so totally from that of armies ordinarily—the ranks being made up of the best people of the land—that ladies, forming the society of the country, have taken a very conspicuous part not only in the formation, but in the preservation, of our ar-

mies. They have given up their sons, husbands, and fathers willingly to their country's call; have fed and clothed them while in the field; and when stricken down by disease, or the enemy's missile, they have taken their places by the couch of pain, and, by their gentle and assiduous attentions, have mitigated largely the horrors of war. They have established hospitals, and, by private means and their individual efforts, have successfully conducted large establishments—living memorials of their patriotism and devotion. Without the instrumentality of the noble women of the Confederate States, in toning political opinions, in infusing the fire of patriotism, in dispelling doubts, fears, and gloom, in exhibiting a courage and boldness in the presence of danger, an unshaken confidence in ultimate success, a settled faith, a boundless liberality, and a devotion to the soldier, our struggle for independence would have been a much more serious undertaking, and success much more doubtful.

The dieting of patients in a hospital is always a matter of considerable moment, and one which requires much attention. The surgeon has discretionary powers to order any extras which the patients may need, and which the issue of rations does not include. To be enabled to supply these extra articles at a time when they are wanted, the surgeon in charge of a hospital is furnished with funds, for the judicious outlay of which he becomes personally responsible.

This hospital fund for supporting the commissariat of a hospital, is collected by commuting the number of rations which the patients are entitled to draw, at a certain rate, changed from time to time by the government. The hospital is allowed to purchase at

cost such articles as the commissary department can furnish, which amount is charged against the daily allowance and the hospital credited with the difference, which may be either left in the hands of the commissary, he paying all bills contracted for the comfort of the sick, when approved by the surgeon in charge, or the cash difference between the ration drawn and the amount allowed is turned over to the surgeon in charge of the hospital, to be expended by him for the benefit of the patients, either for luxuries, comforts, or articles of hospital furniture—the purchases not being restricted to articles of subsistence. This fund is ample to meet every want of the sick.

For the very sick, the dietary orders being individual, no difficulty exists in prescribing for them. It is for those drawing ordinary fare, and who require to be guided by some fixed rule, that diet tables are found so useful in diminishing the daily routine duties of the surgeon. This diet list is carefully compiled by the surgeon in charge of the hospital, and contains those articles of diet which would be best suited to the many, and which the markets at the same time can readily furnish. As this is a *sine qua non* in a hospital, and gives much trouble in its preparation, I have here introduced, as a guide, a diet table, which might be useful as a basis in preparing one for individual hospital service.

Two drachms of tea or four of coffee, with one ounce of sugar and one-eighth pint of milk, to be allowed to each patient for one pint of tea or coffee, morning and evening.

The beef or mutton, for full or half diet, is to be made into soup, with vegetables, and one pint of soup given to each patient, with his proportion of the boiled meat. The vegetables, as rice, potatoes, or

beans, are frequently changed, to give variety to the meal.

A Scheme of Diet for Patients in the Military Hospital.

FULL DIET.	HALF DIET.	LOW DIET.
Bread ....1 lb.	Bread ....½ lb.	Bread ....½ lb.
Beef or mutton ...½ lb.	Beef or mutton ....¼ lb.	Tea ... .½ oz.
Potatoes, or } ....1 lb.	Potatoes, or } .....1 lb.	Sugar ....2 oz.
Beans, or .. } ....4 oz.	Beans, or .. } .....4 oz.	Milk for tea....4 oz.
Rice....... } ....4 oz.	Rice....... } .....4 oz	Corn meal .....1 lb.
Veget'es for soup. .4 oz.	Veget'es for soup. .4 oz.	Milk ....1 pt.
Salt ....1 oz.	Salt ....1 oz.	....
Tea, or } ....½ oz.	Tea ....½ oz.	....
Coffee, } ....1 oz.	Sugar.............2 oz.	....
Sugar ....2 oz.	Milk for tea.......4 oz.	....
Milk for tea......4 oz	Molasses..........1 oz.	....
Molasses..........1 oz.	Corn meal ....1 lb.	....
Corn meal ....1 lb.	Soup ....½ pt	....
Soup ....1 pt.	....	....

Veal, fowls, or bacon: Such quantities, in lieu of beef and mutton, as the medical officer may prescribe.

Wine, whiskey, porter, or ale, at the surgeon's discretion.

The diet would be distributed in the following order:

	FULL.	HALF.	LOW.
BREAKFAST.	Bread.........½ lb.	Bread.........½ lb.	Bread....¼ lb.
	Tea or coffee..1 pt	Tea............1 pt.	Tea......1 pt.
	Hominy & molasses.	Hominy & molasses.	Gruel....½ pt.
DINNER...	Beef or mutton.½ lb.	Beef or mutton.¼ lb.	....
	Soup..........1 pt.	Soup..........1 pt.	Gruel....1 pt.
	Bread.........½ lb.	Bread.........½ lb.	Milk.....1 pt.
	Beans, potat's or rice	Beans, potat's or rice	....
SUPPER....	Bread.........½ lb.	Bread.........½ lb.	Bread....¼ lb.
	Tea or coffee...1 pt.	Tea...........1 pt.	Tea......1 pt.
	....	....	Gruel....½ pt.

The attending surgeon adds what he wishes to the above diet, to suit any individual case in the hospital.

CHAPTER III.

MEDICAL SERVICE OF THE ARMY—THE MEANS OF TRANSPORTING THE SICK AND WOUNDED—HAND-LITTERS—HORSE-LITTERS—AMBULANCE WAGONS, ETC.

The transportation of the sick and wounded of an army is always a matter of difficulty, and is not uncommonly the indirect cause of an increased mortality. The injury inflicted upon a wounded man by a transportation of even a few hours over bad roads, and in unsuitable vehicles, is incalculable. Wounds which had been doing well prior to the move, take on at once an unhealthy appearance: some slough, erysipelas or mortification shows itself in others, while all feel more or less its malignant, injurious influence, even with the best transports, and under the most favorable circumstances. The jolting of a broken limb for three or four hours over a rough road, is indescribable torture. The prostration and exhaustion depicted upon the faces of the wounded after such a transfer, explains at once the problem why such numbers die during their transportation, and makes us wonder how so many escape with life, after undergoing such unutterable hardships.

The transportation of the sick should also be a source of anxious solicitude on the part of a quartermaster whose humanity has not been bereft of every spark of sympathy. It is said that, in the service, a familiarity with suffering and privation, and the usual demoralizing agents always at work and so widely diffused through an army in the field, destroy all the

finer feelings of a man, making him not only careless of self, but callous to the wants of others. It is only similarity of suffering that can produce sympathy in feeling. Could those in the quartermaster's department undergo the same treatment which falls to the lot of the sick and wounded during transportation, there would be a few more comforts extended to those who are periling their lives for their country's safety.

The following are the usual modes of transporting those wounded during a battle:

Litters.—The common and best means of moving wounded men, for short distances, is upon litters, which may be prepared in advance, or be an impromptu manufacture. In case of necessity, a litter can be improvised from the blanket of a soldier. This is doubled upon itself, a slit being made through the end corners sufficiently large to admit the barrel of a musket; one musket is passed through the fold of the blanket, another through the slits in the ends, and a litter is ready for use. Soldiers' blankets are at times prepared for this service, by having strong loops sewed to the corners, so that when the blanket is doubled the four loops will come on one straight side; one musket is passed through the four loops, the second between the folded blanket. Where comrades from the ranks are expected to carry off the wounded, this is the only litter which is of service, as any two soldiers are always prepared to act as carriers without hampering themselves during the fight with extra baggage. Such a litter is, however, very defective, as the weight of the patient sags the yielding blanket until it nearly reaches the ground, while the muskets are pressed in upon the haunches of the bearers, which renders it impossible for them to proceed with ease or celerity

A more useful and equally simple litter or stretcher is made of strong sacking or canvas, six feet four inches long and two feet wide. A broad hem is taken up on either side, through which passes a stout pole eight feet long. Two iron or steel rods, two feet long, terminating in rings at the extremities, slip over the ends of the poles and form the stretchers. These keep the poles separated and prevent any sagging of the litter. A shoulder strap, with loops to receive the poles, completes an apparatus which is capable of carrying off a wounded man with all the comfort which his situation admits. A pike-head attached to the pole makes it a formidable weapon of defence. Each of those who are expected to transport the wounded is armed with such a pike, and carries one iron stretcher and canvas bottom strapped upon his knapsack. Any two of these carriers meeting together will be enabled, in a few minutes, to equip an efficient litter. When laid on the litter, the soldier's knapsack is under his head as a pillow, and his musket lies alongside of him, or may be hung from the side of the litter by loops placed there for that purpose. This is the best litter that can be devised for an army in which there is deficient transportation, and in our service should be generally adopted, as they will be borne by the ambulance corps without complaint, and will be always at hand when required.

A *framed litter* is one of very questionable utility, as it is a very bulky article, and one easily broken, so that usually, after a long march, very few of them are fit for service.

The litters used in the Confederate service, as seen in plate 1, are composed of canvas, twenty-four inches wide, securely tacked to two horizontal bars eight feet long; the stretchers, which slip over the handles,

and to which the canvas is temporarily secured by straps, being a square bar of wood, with a loop of band iron over the ends, forming the eyes through which pass the handles. These are convenient, as they fold in a small compass for transportation. As the stretching apparatus, which is loose, is sometimes lost or misplaced, which renders the litter useless, it may be secured to the side bars by substituting for the iron loop hinges or hooks. A steel rod, folding upon its centre, can be so connected to the sides of the litter beneath the sacking as to unfold with the litter, and act as a stretcher without fear of becoming detached. Short folding legs, working upon an iron pivot, and kept in place by a stop-block or an iron hook, complete the apparatus. In the Confederate service ten of these form the quota of each regiment in the field.

These framed litters have been a source of constant annoyance to regimental surgeons. To be made strong enough to bear the ordinary usage for which they are intended, they are necessarily heavy, and therefore a cause of complaint with the ambulance corps, whose duty it is to bear them. Our wagon transportation having been always deficient, with no room for litters in the hospital wagon or ambulances, the litter-bearers, to relieve themselves of the weight of a litter, *accidentally* break the woodwork against a rock or tree, and then rip off the sacking, which they afterward use as a litter by cutting holes in the four corners and using two poles cut by the roadside, when they are called upon to convey wounded men. Others throw away the litters as soon as they are annoyed by the weight. Unless the infirmary corps are made responsible for the litters which are put in their possession, and be made to pay for any loss or

injury sustained, litters will always be deficient in our army.

Another objection to the framed litter, especially with feet, is that they are often used as beds and lounges for officers, although this application is expressly prohibited, and while thus used are frequently broken by persons throwing themselves upon them, or sitting upon one of the sides. As the feet are seldom required, it is an improvement to omit them in the construction of litters.

Williamson, in his Notes on the Wounded from the Mutiny in India, published in 1859, has, in the appendix, a plate and description of a *dooley*—a kind of litter used for the conveyance of the sick and wounded in India. In the field service it forms the patient's bed as well as means of conveyance, from the time of his being wounded until he is either cured or dies. It consists of a framework, resembling a bedstead in miniature, six and a half by two feet, with light posts, which run below the bed six inches. This is slung by two ropes placed on either side from the head and foot, and running up triangularly—the pole upon which the litter is supported passing through the apex of these two triangles. A tarpaulin cover, with side curtains, excludes the sunlight and gives privacy to the wounded. When the bearers arrive at the encampment, they run the dooley into the hospital tent, take out the pole with the tarpaulin covering and curtains, with which they make their tent, leaving the patient comfortable in his bed. These were found to answer admirably in the Crimea, where they were used to a limited extent. This is the most comfortable conveyance for a sick or wounded person, and its introduction generally into the English service has been strongly recommended.

Horse-Litters.—Next to hand-litters for the transportation of wounded men are horse-litters, made three feet wide, with poles sixteen feet long, folding in the middle for convenience of transportation. Horses or mules take the place* of men—the poles acting as shafts, and supported by back-straps or by a saddle with tugs, as in ordinary harness. Each horse-litter carries two persons. When the mules are led by men well trained for this duty, transportation by this means is well suited to the comfort of the wounded; but if the muleteers are raw hands, who, holding the mule by the head, attempt to lead it, instead of allowing it to pick its own way, the joltings and sudden jars make this litter anything but a bed of down.

The French use what is called a *cacolet*, a kind of arm-chair, which is suspended on each side of a pack-saddle upon a mule. The mechanism of this chair is so arranged that it can be unfolded, so as to be converted into a bed or a litter. It offers either a comfortable seat for the trivially wounded, or a bed for the more serious; and each mule can thus carry two men comfortably from the field to the infirmary. In hilly countries, over bad, rough roads, this is found a much better conveyance than vehicles.

The *two and four-wheeled carriage or ambulance wagons*, which have been adopted in every civilized army, are considered indispensable for field service, and for the transportation of the wounded. Both are so arranged as to allow of the wounded being carried lying, reclining, or sitting. The omnibus is the most expeditious means of removing those slightly wounded, who are not able to walk from the field. Where the roads are good, in an open country, this vehicle should not be overlooked. The four-wheeled spring ambulance wagon is the most comfortable for the wounded, and also the most useful for the service.

In the Confederate service the four-wheeled spring wagon, as seen in plate 1, is the one in general use, although the two-wheeled wagon is also used. It consists of a box body, three and a half feet wide and seven and a half feet long, placed upon three springs. Two stuffed seats run the entire length of the wagon; and the drop from this, which is attached to the seat by hinges, and is equally cushioned, can be elevated horizontally, and supported by feet, which, with the seat, will form a continuous bed over the entire wagon. Such wagons will transport two men lying, or from ten to twelve sitting—the inmates being protected from the sun and rain by a cloth cover and side curtains, supported upon a frame. Two five-gallon kegs, secured under the bottom of the wagon, carry water for the sick and wounded.

The Coolidge, two-wheeled ambulance wagon, which is in use in the Federal army, is a very ingenious but complicated arrangement, and is liable to be broken by the ordinary uses of the service. In these, instead of seats, there are two frames, which can be used as litters. These run upon rollers on the bottom of the wagon. The frames have folding legs and sliding handles, which occupy no available room. Upon the top of the litter is a frame, divided into three portions, folding in such a way that the head of a wounded man can be elevated nearly to a sitting posture, or the leg equally elevated, should the peculiarity of the wound require it. A partition through the body of the wagon separates the two patients which the interior of the wagon accommodates. Under the driver's seat is a box, which can be used as a medicine-chest. This vehicle is intended for one horse in shafts, or two in tandem.

When transportation is abundant, the Confederate

service allows, for every command of less than three companies, one two-wheeled transport cart for hospital supplies, and to each company one two-wheeled ambulance carriage. For commands of more than three or less than five companies, two two-wheeled transport carts, and to each company one two-wheeled ambulance carriage. For a battalion of five companies, one four-wheeled and five two-wheeled ambulance carriages, and two two-wheeled transport carts; and for each additional company, less than ten, one two-wheeled transport cart. For a regiment, two four-wheeled ambulance wagons, ten two-wheeled ambulance wagons, and four two-wheeled transport carts. This number, however, has never been received by a regiment, and often one wagon for transporting the hospital apparatus, and one four-wheeled (rarely two) ambulance wagons complete the actual supply to regiments in the field.

Where there are many sick to be moved from camp to a general hospital, should the transportation in ambulance wagons be deficient, advantage is taken of the return of empty commissary wagons to the rear to send off the sick, and vehicles of every description may be impressed for this special service.

CHAPTER IV.

Medical and Surgical Staff of Armies—The Medical organization in the Confederate service; English service; French service; Prussian service—Infirmary Corps, or litter-carriers for transporting the wounded from the field—Duties of the Hospital Surgeon—Duties of the Regimental Surgeons and Assistants in camp and on the battle-field—Medical supplies allowed in the field—Preparations needed on the eve of a battle—-Positions occupied by the Medical Staff during the fight.

Medical Service of the Army.—The medical staff of an army is selected with care by an examining board, whose rigid inquiries into the literary and professional attainments, as well as into the moral and physical condition of the applicant, keeps the staff purged of inferior men, and forms a body of scientific investigators whose efficiency will compare favorably with the profession of any country.

During war, the medical department increases *pari passu* with the army. These appointments should be made with a full knowledge of the weighty responsibilities attached to the medical staff, without whose constant solicitude for the health and well-being of the troops committed to their care, the effective strength of an army will be materially reduced. With a view to ensure, at all times, the most active and efficient treatment for the sick in the army, and particularly during active service, it is not only essential that the medical officers should be men of ability and of high professional qualifications, but that they should possess physical energy adequate to their arduous duties.

It is a common impression that surgeons alone are wanted in the army, under the erroneous belief that the only risks to which troops are exposed are the bullets of the enemy. As we have elsewhere shown that for one killed by the enemy at least eight die of disease contracted in camp, this will be sufficient proof that the physician must be even more important than the surgeon. Long before the first shot is fired, there are diseases to contend against. Whether in camp or on the march, diseases are constantly developing themselves. Surgery has its periods, and although hospitals may be filled with wounded men immediately after a fight, beds are soon vacated to be refilled by the ever-coming sick. Some of the wounded die, a large proportion rapidly get well and are discharged, and the protracted cases are sent home to recruit; but these leave no vacancies, as their places are immediately filled by the sick.

The advantages of having an experienced surgical staff in the field, and the influence which it can exert on the vicissitudes of war, must be acknowledged by every thinking man. Yet, medical advice is seldom asked or listened to by those in command, so long as suffering and death are not cruelly felt. The proper understanding between the surgical and military staff of an army, with concert of action, will save many a soldier, who would otherwise lose or compromise his life, so valuable to the country in time of need.

In the Confederate service but two grades in the medical staff are recognized—surgeons and assistant surgeons, with the respective assimilative rank of major and captain. The head of the medical department is presided over by a surgeon-general, with the rank of lieutenant-colonel of cavalry, which is the highest grade in the service, and which position is held

by seniority of commission. There are other meritorious positions, viz: of medical directors and inspectors for field and hospitals, and medical purveyors of the army, which are appointments by the surgeon-general, and are considered offices of responsibility and trust, although without increased rank.

In the Confederate service each regiment, nominally of one thousand men, has one surgeon and one assistant surgeon. Where several regiments are united into brigades, the oldest commissioned surgeon in the brigade assumes the position of brigade surgeon, who, however, is not relieved from regimental duty. When brigades are thrown together into divisions, the surgeòn upon the staff of the major-general assumes the position and duties of division surgeon. The union of several divisions, comprising a *corps d'armée* under the command of a lieutenant-general, has a chief medical officer with the title of corps surgeon, or medical director of the corps; and when two or more *corps d'armée* form an army, the medical affairs of such a body of men is supervised by a medical director recommended by the surgeon-general, and appointed by the Secretary of War, at the solicitation of the general in command.

In times of peace, two medical regimental officers are found scarcely sufficient to attend to the sick; while, in times of epidemics or war, they are incompetent to offer that assistance which the sick and wounded require. Many a life has been sacrificed to procrastination. Upon the first and immediate attention to the wounded on the battle-field depends, in a great measure, the success of treatment; and in any encounter which deserves the name of a battle, the wounded must necessarily be neglected by this deficient medical staff.

Our large experience has proved the inefficiency of our regimental medical staff. European experience confirms the observation, that two medical men are not sufficient to take care of the health of a full regiment of a thousand men. This was the subject of general comment in the Crimea, where the medical staff were unanimous in the demand for additional medical assistance. In active service, every full regiment should have at least one surgeon and two assistant surgeons, these differing only in rank, their duties being similar. Besides the regular regimental surgeons, there is in the Confederate service a medical corps to take charge of military hospitals, while regimental officers accompany their commands.

In the *English service*, the medical department is composed of regimental surgeons, with their assistants, staff surgeons of the first and second class, and medical inspectors. The staff surgeons of the first class rank the regimental surgeons, and, with their assistants, either take charge of military hospitals, or act as medical supervisors for a brigade, composed of three or more regiments. The assistant staff surgeon holds the same rank as the regimental surgeon. When many brigades are collected into a division, a staff surgeon of long service is appointed to direct the medical and surgical affairs of the division; and when a large force, consisting of several divisions, with their respective generals and physicians, is brought into the field for actual service, and placed under a general-in-chief, a medical staff officer, bearing the title of inspector-general, is appointed to superintend and concentrate all the movements of the medical department of the army. The medical department takes the military, therefore, as its model.

In the *French army* a somewhat similar organiza-

tion is found. Besides surgeons and assistant surgeons attached to regiments, the military hospital staff, which is a very numerous one, consists of medical inspectors or head surgeons of infirmaries, staff surgeons of the first class, with senior and junior assistants—the number detailed for special hospital duty depending upon the size of the institution and the number of its inmates.

The most thorough medical organization in Europe belongs to the *Prussian service*, and is composed as follows:

Each battalion of one thousand men has a surgeon and assistant surgeon, who are thoroughly instructed in the duties which they are expected to perform. Beside these there is, to every *corps d'armée* of thirty thousand men, a staff of forty surgeons, who, in time of war, take charge of the general military hospitals opened for the reception of the sick and wounded. This division has also attached to its medical department three infirmary staffs for light field service, composed of eleven surgeons each. These act as a reserve on the battle-field, opening field infirmaries which follow the troops, and give the first aid and dressing to the wounded. This gives a proportion of nine surgeons to every two thousand men; and, notwithstanding this large number, there are periods when even a larger number of surgeons would not be sufficiently numerous to give proper and immediate assistance to the wounded.

In most European armies the dispensing of medicines is performed by apothecaries, who complete the medical organization. In the English service the assistant surgeon or hospital steward acts as apothecary. In the Confederate army, as physicians of experience are numerous in the ranks, one of these

usually receives the appointment of hospital steward in the field, or apothecary, with the rank of hospital steward in the general hospitals, and upon him devolves the preparation and dispensing of drugs.

In recent European campaigns a very important addition has been made to the surgical service. It is the *ambulance corps*, or *carriers of the wounded*. Heretofore, when men were shot down from the ranks, they were borne to the back by their comrades-in-arms, who transported them to the field infirmaries, where the surgeons attended to their wounds. Although a most praiseworthy act of devotion to a fallen friend, it was often called for when help could least be spared, as the taking away of so many fighting men from the ranks enfeebles the strength of the command, and diverts the attention of the soldiers, if its demoralizing effect does not break up the corps. It is also well known that, if any from the ranks are drawn from the fight to carry off the wounded, they never return until the fight is over, and thus three are lost to the company instead of the one wounded. Besides, with the very best intentions, these comrades are not instructed how to carry the wounded so that they should suffer least detriment, and the final result can not be but injurious to the wounded. The ambulance corps, which now forms a very essential part of every army, is a regularly organized body of men, carefully selected for their strength and courage, who are taught how to carry wounded men. These practiced hands are under military discipline, commanded by officers whose duty it is to see that the wounded are promptly and carefully removed from the places where they fall to the infirmaries.

The assistant surgeon of a regiment accompanies the ambulance corps to superintend the judicious

transportation of the wounded. While thus employed he is only expected to offer temporary assistance. Should there be fearful hemorrhage, he may apply a tourniquet, or show the assistants how to compress, effectually, a bleeding vessel. He arranges broken limbs so as to have the wounded man conveyed with the greatest degree of comfort, and gives, perhaps, a dose of morphine when much suffering is felt, but as long as active fighting is going on he has no time to offer more than this temporary assistance.

This ambulance corps, with litters, ambulance wagons, pack-horses, and all other facilities for transporting wounded men, should be in the advance, immediately behind the line of battle. Their post is one of great risk as well as of heavy responsibility; for, not unfrequently, they lose their lives in accomplishing their benevolent task. Both humanity, civilization, and economy dictate that such a corps should be appended to every army in the field. When not wanted on the battle-field, experience makes them careful nurses for the sick and wounded.

The ambulance corps, as connected with each brigade in the Confederate service, is composed of two men from each company of a hundred men, selected for bravery, strength, endurance, and good character—the object being to make this corps as efficient as possible. When suitable in other respects, physicians or students of medicine found in the ranks, are selected. The duties of the ambulance corps are very trying, requiring undaunted courage as well as great endurance, to enable them to work uninterruptedly under fire, following closely the line of battle, with their lives exposed at every moment from the missiles of the enemy, and yet unarmed and without excitement. This brigade ambulance corps is under the command

of a lieutenant. The men, selected from each regiment, two from every hundred men, are in charge of a sergeant, who is frequently a medical man—the conscript law not exempting physicians under thirty-five years of age from military service—and patriotism having induced many of much more extended practice to take the field. The members of this corps are designated by wearing around their caps a red band, with *ambulance corps* printed in conspicuous white letters. Each carries a large canteen filled with water. Their duties are to follow their regiments into the fight, accompanied by the assistant surgeon, and convey to a place of safety such as are shot down and too severely wounded to get off the field without assistance. When the army is in motion, the infirmary corps marches in the rear of its regiment, bearing the five litters now allowed to each regimental corps. When in camp, they are employed about the hospital as attendants upon the sick. In many regiments they are never called upon for guard duty during an active campaign, and are allowed all the privileges granted the color-guard. When an army goes into permanent camp they are returned to the ranks, to resume their duties as an ambulance corps as soon as the campaign is resumed—the men who have been instructed in this duty being continued in it.

The French organization,* which may serve as a model for the formation of a hospital corps, is as follows: One captain, one subaltern, one sergeant-major, one pay sergeant, five sergeants, or upper ward-masters when in hospital, ten corporals or under ward-masters, two buglers (indispensable for sounding halts and advance in the transport of the wounded), ninety-

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*Article Ambulance, Costello's Cyclopedia of Practical Surgery.

six privates or orderlies, one tailor, one shoemaker, one cutler (a most useful artisan to keep surgical instruments in repair), one carpenter, four cooks. When employed in hospital, these are distributed in the proportion of one ward-master for every hundred patients, and one orderly for every twelve. The wagons and cars will also be under the command of their proper officers; non-commissioned officers, with wheelwright, farriers, saddlers, etc., are also to be attached to the corps. When on a march, should there be a deficiency of transport wagons, the ambulance wagons carry the hospital stores, also the packs of weak men not requiring transportation; they also pick up such men as are not able to proceed with their companies, or those who are compelled to fall out of the ranks from indisposition. When troops on a march arrive at a place where good water can be obtained, the hospital corps should fill their canteens for the use of the sick. When the troops are bivouacked, the hospital corps should be employed in throwing up huts, or in establishing temporary hospitals in any adjoining buildings, and in preparing some light food for the sick which they have brought in.

The following is the course pursued by the Prussian medical corps of a division of thirty thousand men when going into battle: The reserve corps of forty surgeons establish a general hospital at some safe and convenient point, four or five miles from the battle-field. Here all the appliances are concentrated for giving proper attention to the injured, and most of the serious and tedious operations are to be performed, under judicious consultation. As this is the resting-place from the field, accommodations must be ample;

every facility for treating successfully the seriously wounded must, therefore, be found, and all hospital stores should be concentrated at this hospital.

Directly behind the line of battle, and movable with it, are placed the light field infirmaries, with their special staffs. They are the way-stations for medical service, as all the wounded pass through these on their way to the general hospital. At these field infirmaries the wounded receive the first thorough examination, and many operations deemed imperative are here performed. All wounds are here cleansed, foreign bodies of every kind extracted, hemorrhage controlled, and the first proper dressing applied. As the wounded are brought to this point as they are shot down, their wounds have undergone but little change; the system is still suffering from a certain amount of nervous shock, which makes it the proper time for effecting a thorough examination without giving pain.

In these, as in the general hospital, there is always a division of labor, and each surgeon, knowing his duty, accomplishes the greatest amount of work in his special department. The division always recognized, is the *examiner*, the *operator*, and the *dresser*. Those who are most skilled in these various departments are expected to give the benefit of their skill and experience to the wounded. More importance is placed upon these subdivisions of labor than we would, at first sight, recognize. It is well known that many hands can be efficiently worked by one head, and that when a surgeon of much experience and mature judgment determines what course should be pursued, there are many competent to carry out his suggestions, who were not sufficiently prepared to establish a thorough diagnosis and foresee the probable issue.

The importance of examining a wound as seldom as possible being acknowledged, it is easy to understand why the most proficient surgeons in the service should be appointed, as diagnosticians, to examine, thoroughly, the wounded, and determine upon a course of treatment. In gunshot wounds, above all others, the necessity for accurate diagnosis becomes imperative, and this first examination should never be slurred over, however urgent the demands upon the surgeon's time. *Except in very obscure cases, a second examination should never be made*, as it always gives pain, increases irritability, heightens inflammation, and permits air to gain access to the very depth of the wound, which is sure to promote the decomposition of the exudates around the wound, with its suppurative and sloughing sequelæ. *Many a limb and life would be preserved were it possible to limit the examination of the wounded to the field infirmary.* Let it be remembered that the first examination is always less painful and dangerous than any subsequent one. All surgeons agree upon the success of primary operations, when compared to secondary, after inflammation has set in. How to proceed, or what wounds to condemn, requires nice discrimination—hence the necessity of devoting the talent and experience of the staff to this very important duty.

In the Prussian service, the regimental surgeons are concentrated in groups with their assistants, rather than follow their respective regiments into the fire. Thus, much time is saved and the wounded receive more attention; and keeping them together in this way renders it easy to command medical service when it may be needed for any special extra duty. This, of course, does not prevent surgeons being sent to various points of the line, to assist the medical por-

tion of the sanitary corps in the proper transportation of the wounded.*

In the same service, the primary dressings for the wounded are carried by each soldier, so that all necessary bandages are on the spot, and no time is lost waiting for the bandage boxes or hospital stores. The general plan adopted by the entire army is as follows: Every soldier carries a small package, three inches long and one inch thick, which contains the following articles, viz: two pieces of old, soft, clean linen, nine inches square; a piece of oiled silk or india-rubber tissue, nine inches long by five inches wide; a small ball of lint; a bandage two and a half yards long and two inches in width. One piece of the linen is folded double and rolled tightly over the lint, and over this the piece of oiled silk is rolled, the bandage rolled around this, and the whole enveloped in the second piece of linen, and fastened with two pins. This should be put in a particular place in the knapsack, where it can always be found. Should there be two wounds, the oiled silk and cloth may be divided to make a double dressing, and one piece of cloth may be used by the surgeon as a towel. In this small but very useful package is found the requisite dressings for every gunshot wound. It saves the surgeon the annoyances and delays incidental to the transportation of hospital stores. In the light field infirmaries, nearly all the dressings of the wounded are obtained from this individual package—the very few extra articles needed being furnished from the infirmary supplies.

Stromyer, in his surgical writings on the Schleswig-Holstein war, speaks of the medical department of the army as modelled upon the military. Besides the

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*Lœffler. Behandlung der Schusswunde. Berlin: 1859.

regimental surgeons, each brigade had a brigade surgeon with three assistants. The larger divisions of the army were equally supplied with superior medical officers and staff. On the battle-field the surgeons of the army established infirmaries for the immediate care of the wounded, who were, after the first dressing, sent into the more permanent infirmaries.

Modern warfare, in introducing arms of precision, of immensely increased range, and perfected instruments of destruction of heavy calibre, has created a new era in military surgery. The conical ball of double weight has become the common missile, and when discharged from a rifle it flies with fearful velocity. Such balls, when traversing soft parts, produce extensive destruction, but seldom bury themselves. Comparatively few of these are to be extracted after a battle. Should they impinge upon a bone, the splitting and crushing is so extensive as to necessitate more frequently amputations and resections.

This conical ball seldom fails to take the shortest cut through a cavity or limb, and it has at times been seen to pass through the bodies of two men and lodge in that of a third. Rarely are they deflected from their course, as is the round ball, which is turned by every little obstacle, taking up a position at striking variance with any rule of propulsive forces. In steady hands frightful wounds are produced by the minie ball, which require all the resources of surgery to manage successfully.

The following interesting table, taken from the recent work of M. Legouest on Army Surgery, published in Paris in 1863, will give an idea of the relative momentum, and the relative tendency to do mischief, of round and rifle balls. To exhibit the power of penetration of balls, a target was made

by setting up plank of one inch in thickness, twenty inches apart, each numbered as in the following table:

		Nos.	1	2	3	4	5	6	7	8
Round ball from a smooth bore at 500 yards	120 shots.	Perforated	2	1	...	...	...	...	...	...
		Lodged	2	...	...	...	...	...	...	...
		Impression on plank	...	1	...	...	...	...	...	...
Conical shot from a rifled piece at 500 yards	120 shots.	Perforated	63	55	52	43	32	14	3	1
		Lodged	...	3	10	2	4	1	...	...
		Impression on plank	..	5	3	6	7	12	7	...

By an examination of this table it will be seen that, with the round ball and smooth bore, at a distance of five hundred yards, only two shots perforated the first plank, and one only, out of one hundred and twenty shot, traversed the second plank of one inch in thickness; while the majority of the rifled conical shots perforated the first plank, a large number the second, third, fourth, and even fifth, while one traversed the entire target of eight planks—which indicates, in a very striking manner, the facility with which rifled conical shot overcome the resistance of opposing bodies, and accounts for the straight course which they usually take through a limb, and the rarity of their incarceration in the tissues.

In making experiments for the above table, it was also remarked that, for the first two hundred yards from the muzzle of the piece, the round ball moved with the greatest velocity; this was readily overcome, however, by atmospheric resistance, and gravitation soon brought it to the ground. In all instances where a mark was shot at from a distance of two hundred yards, the round ball was the first to strike; over this distance the velocity of the round ball was rapidly diminished; while the conical ball shot from the rifle continued its momentum undiminished.

Another missile, which has been more extensively

used in the present war than in any preceding, is the rifled shell, as fired from artillery. In both contending armies rifled artillery appears to be a weapon upon which much reliance is placed, and which is brought into continual use—artillery duels not only preceding each battle, but being a constant element in the fight. Whether used at a distance of five miles, as in the Siege of Charleston, or at short range, the explosion of shells among troops makes frightful wounds. The mutilation of the slain upon every battle-field attests the terrible efficacy of the rifle shell and modern artillery missiles.

Let us now define the duties of a surgeon in the Confederate service in the regimental hospital, in camp, and on the battle-field.

Camp Duties of a Regimental Surgeon.—We have already shown that the fire of an enemy never decimates an opposing army. Disease is the fell destroyer of armies, and stalks at all times through encampments. Where balls have destroyed hundreds, insidious diseases, with their long train of symptoms, and quiet, noiseless progress, sweep away thousands. To keep an army in health is, then, even more important than to cure wounds from the battle-fields. But, as surgeons in the service are expected to be skilled in both departments, so that, in either case, the troops under their care might suffer no detriment, they should be thoroughly prepared for the very responsible positions which they fill. Conservative surgery requires much more at the hands of the surgeon than the destructive practice of former times. Every surgeon should now prepare himself for the field, by familiarizing himself with operative surgery. Half-knowledge leads to meddlesome surgery, which is far

worse than no surgical assistance. *Many a wounded soldier has felt heavily the busy hand of the willing surgeon who lacked the guiding head.* The surgeon in the Confederate service has charge of a number of very valuable lives, as the very best men in the country are in the army, and the necessity imposed—by the absence of consulting aid—of deciding the most serious and critical cases upon his own unaided judgment demands, upon his part, self-reliance, which can only be based upon previous preparation. Camp life gives a surgeon much food for thought and ample personal experience, but gives him no time to consult authors and improve himself with books. He does not see so great a variety of diseases as are met with in civil practice, but he has a wider field for observing the influences of external modifying circumstances—as exposure, improper food, imperfect clothing, irregular work, want of cleanliness, and depressing or exhilarating mental influences upon young, healthy men. The diseases of a soldier, like those of most trades, are peculiar—each trade begetting its own, while it gives immunity to others. The greater uniformity in age, constitution, modes of living, exposure to similar external influences, and strict discipline, modify, to a considerable extent, the diseases of camp. It is especially the crowding together, with the animal emanations from such a number of living beings, that gives character to the phases of camp disease.

The preservation of the health of the soldier being the sole duty of the military surgeon, he will be expected to use every means within his reach to attain this desirable end, and more especially by a rigid observance of those forms of discipline and economy which are under the direction and surveillance of the military officers. As diseases will arise among troops, and as

very few of these can not be arrested by means of art when skilfully applied at an early period, care should be taken that medical skill be promptly resorted to at the very first sign of indisposition. Hygiene must first claim his attention, under the adage, "Prevention is better than cure." If the troops are about forming an encampment, he must examine the ground, and see whether any causes exist for rendering the place insalubrious. When in a friendly country, he should seek information from the local physicians, which will not only give him a better insight into the sanitary condition of the point selected, but will also instruct him upon the diseases prevalent in the locality, and the means which local experience and observation have proved most effective in controlling such diseases. He must see that, when practicable, the troops in camp are supplied with dry straw for beds, and that they air the same daily, along with their tents, so as to ensure a healthy place for repose. With the officers of the regiment, he must see to it that the soldiers are properly clothed, and well fed with wholesome, nutritious food, and supplied with an abundance of good water, and, from time to time, should suggest to the commanding officer such changes in the diet as will be conducive to the health of the command. If the water is bad, he should study how it can be improved, so as not to act injuriously upon the men. Cleanliness of the encampment, of the tent, and also of the body and clothing of soldiers, should never be forgotten. He should point out to the commanding officer all nuisances which promise to be detrimental to the health of the corps, and *urge* their removal—suggesting how they can best be disposed of. Much of the sickness in the

army can be attributed to a dereliction of this duty upon the part of the medical officer.

The hospital tents, with the approbation of the commanding officer, will be pitched upon a dry, well-drained spot, if a building can not be obtained for hospital use, and it is the duty of the regimental surgeon to attend to the proper furnishing of the same with all possible conveniences for the sick. He will enforce all proper hospital regulations to promote health and prevent contagion, by ventilation, scrupulous cleanliness, frequent changes of bedding, linen, etc.

At the surgeon's morning call the sick of the regiment will be conducted to the hospital by the first sergeants of the various companies, who will each hand to the surgeon a list of all the sick of the company, on which the surgeon will state who are to remain or go into hospital, and who are to return to quarters as sick or convalescent; what duties the convalescents, in quarters, are capable of performing; what cases are feigned, and any other information in regard to the sick of the company he may have to communicate to the company commander. He will then distribute the patients in the hospital; see that they are properly provided with comfortable beds; enter, in the proper register, the name, rank, company, and disease, and in the diet and prescription book the medicines which the case requires. If his assistant is not present, and his steward is not competent, he prepares the medicines and superintends their administration. He will visit the hospital each day, as frequently as the state of the sick may require. Should any soldier be taken suddenly sick, his case is at once reported to the surgeon, who will

visit and prescribe for him in his tent, unless the case threatens to be serious, when he should be removed without delay to the hospital.

Convalescents, on coming out of the hospital, are not to be put on duty till the surgeon certifies to the commanding officer that they have perfectly recovered; for which purpose it is the duty of the surgeon to make, daily, at morning parade, a particular inspection of these men, so as to prevent any remaining longer exempt from duty than the state of their health renders absolutely necessary. After the surgeon's call, he will make a morning report of all the sick and disabled to the commanding officer. He also recommends that leave of absence be granted, on furlough, to those convalescents who will recover more rapidly by change of air, scene, and life; or discharges for those whom experience has proved physically unfit for the arduous duties of camp life. When it is his opinion that a case can not be as conveniently treated in camp as in a general hospital, he recommends a transfer to the commanding officer, and forwards with the patient a descriptive list, a history of the case, and the course of treatment which has been pursued.

When soldiers are discharged, as cured, from the hospital, or die, or are furloughed or discharged from service, it is the duty of the surgeon to notify, immediately, the captain of the company to which the soldier belongs, so that the proper steps may be taken which the necessities of the case may require.

The regimental surgeon is the recognized head of the regimental hospital, and is responsible for the organization and proper keeping of the same. He will, therefore, prepare and enforce all of those rules so necessary in a well-regulated hospital, for estab-

lishing order and keeping up a military organization. When soldiers enter such a hospital, all control from without is suspended, and line or staff officers are not allowed to interfere in any way with the management of the case. The surgeon distributes the patients, according to convenience and the nature of their complaints, into hospital tents, or leaves them in their own quarters, and visits them each day as often as the state of the sick may require, accompanied by the steward and nurse. He keeps the proper register of the hospital, and directs the prescription and diet of the sick; superintends the preparation of the reports, records, pay-rolls, and descriptive lists; and also keeps a constant supervision over the dispensary, instruments, medicines, and hospital stores, as also over the hospital expenditures, and the preparation of the requisitions and returns. He keeps an order and letter book, in which is preserved copies of all requisitions and invoices, as well as all orders and letters relating to his duties. He makes a monthly report to the medical director, and a quarterly report to the surgeon-general, of the sick and wounded and of deaths, and also of certificates for discharges from disability—all of which are forwarded through the brigade, division, and corps surgeon to the medical director. He will also prepare the muster and pay rolls of the hospital steward. Should a soldier die in the hospital, the surgeon takes charge of his effects and reports the same, turning over all money and other articles except clothing to the quartermaster of the regiment, taking therefor receipts in duplicate, one of which he forwards to the commander of the company of which the soldier was a member, to be sent by him to the family of the deceased, and the other to the Second Auditor of the Treasury. He will enforce the proper hospital

regulations to promote health and prevent contagion, by examining daily into the hygienic condition of the hospital as regards cleanliness, ventilation, over-crowding, proper food, etc. He will require the steward to take due care of the stores and supplies, to keep a regular account of all issues, to prepare the provision returns, and to receive and distribute the rations.

As the sick in all hospitals are not able to consume the ample supply of food which the government recognizes as a ration, and which is issued to all soldiers, whether well or sick, the surgeon should direct the steward to draw from the commissary only such quantities as are required for the hospital, and to commute in money for the stores not drawn. This surplus forms a hospital fund, an account of which the surgeon keeps, and which can be expended for comforts for the sick, both as regards subsistence or hospital furniture. The condition of this fund is transmitted, monthly, to the surgeon-general.

All requisitions upon medical purveyors for hospital and medical stores must come from the senior surgeon, with the approval of the commanding officer, certifying that the same are necessary for the sick, and that the requisition conforms strictly to the supply-table for field service. These requisitions are drawn out by the surgeon in the proper form (No. 5 of Medical Regulations), always in duplicate, stating what medicines are on hand, and for how many required, and are sent to the medical director, or, should there be no one acting in his district, to the surgeon-general, for approval. All stores received from the medical purveyor must be receipted for in duplicate to the surgeon-general, by the senior surgeon, who also notifies the medical purveyor of their reception.

The following comprises the medical outfit for a regiment medicine-chest:

ARTICLES.	QUANTITY.	VESSELS.
Aluminis	1 lb.	5 tins with lids.
Camphoræ	1 "	
Cerati Simplicis	1 "	
" Resinæ	1 "	
Emplastrum Cantharidis	1 "	
Alcoholis	1 bot.	5 tins corked, 1¼ pints in each.
Copaibæ	1 "	
Oleum Olivæ	1 "	
" Ricini	1 "	
" Terebinthinæ	1 "	
Acacia, pulv.	1 lb.	11 tins with covers.
Capsicum, pulv.	½ "	
Magnesia Sulphatis	1 "	
Potassæ Bitartratis	1 "	
Pulveris Cinchonæ	1 "	
" Lini	¼ "	
" Rhei	¼ "	
Quiniæ Sulphatis	¼ "	
Sinapis Nigræ	1 "	
Sodæ Bicarbonatis	1 "	
Sulphurus Loti	1 "	
Acidi Tartarici	8 oz.	6 half pint salt mouth bottles.
Hydrargyri Chlor. Mitis	8 "	
Plumbi Acetatis	8 "	
Potassii Iodidi	8 "	
Pulveris Opii	4 "	
Sodæ et Potass. Tartratis	8 "	
Chloroformi	8 oz.	8 half pint glass stopper tincture bottles.
Liquoris Ammoniæ	8 "	
Spiritus Ætheris Comp.	8 "	
" " Nitrici	8 "	
Syrup Scillæ	8 "	
Tinct. Opii	8 "	
" " Camph.	8 "	
Vini Colchici Seminis	8 "	
Hydrargyri Cum Creta	2 oz.	4 two oz. salt mouth bottles
Pulveris Aloes	2 "	
" Ipecac. et Opii	2 "	
Zinci Sulphatis	2 "	
Argenti nitratis, fused	1 oz.	Vials of different kinds.
Antimonii et Potass. Tartratis	1 "	
Ferri et Quiniæ Citratis	1 "	
Iodinii	1 "	
Morphiæ Sulphatis	⅛ "	
Unguenti Hydrargyri	½ lb.	3 jars or tin boxes.
" " Nitratis	½ "	
Massæ pil. Hydrargyri	½ "	

ARTICLES.	QUANTITY.	VESSELS.
Bandages, roller, assorted	6 No.	
Emplastrum, adhesivi	1 yd.	
" Ichthyocollæ	1 "	
Measures, graduated	1 No.	
Mortar and Pestle	1 "	In the tray.
Oleum Tiglii	1 dr.	
Pencils, hair	½ doz.	
Pilulæ Cathartic Comp.	8 "	
" Opii	4 "	
Scales and weights	1 pair.	
Spatulas	2 No.	
Sponge	1 oz.	
Tiles	1 No.	

A store-chest, with the following contents, accompanies the medicine-chest:

ARTICLES.	QUANTITY.	ARTICLES.	QUANTITY.
Instruments. Amputating, sets ..No.	1	Cotton Batting ... lbs.	1
Ball Forceps ... "	1	" Wadding ... "	1
Bougies, gum elastic ... "	2	Flannel, red ... yds.	2
Catheters ... "	2	Hatchets ... no.	1
" silver ... "	1	Hones ... "	1
Cupping-Glasses ... "	8	Ink, 2 oz. bottles ... "	1
Pocket Sets ... "	1	Lint ... lbs.	2
Lancets, spring ... "	1	Muslin ... yds.	6
" thumb ... "	2	Needles ... nos.	25
Probangs ... "	2	Paper envelopes ... "	25
Scarificators ... "	1	" wrapping ... quires.	2
Splints. assorted (set of 14) ... "	1	" writing ... "	4
Syringes, enema ... "	2	Pencils, hair ... Nos.	8
" pænis ... "	3	" lead ... "	4
Teeth, extracting, sets ... "	1	Pens, steel ... doz.	1
Tourniquets, field ... "	4	Pins, assorted ... papers.	2
" spiral ... "	1	Razors ... no.	1
Trusses, Hernia ... "	2	Razor-Strop ... "	1
Arrow-Root ... lbs.	3	Scissors ... "	2
Candles ... "	1	Silk, surgeons' ... oz.	¼
Nutmegs ... oz.	3	Sponge ... lbs.	½
Tea ... lbs.	10	Tape ... pieces	2
Whiskey, quart bottles ... doz.	1	Thread, linen ... oz.	1
Bandages roller ... "	4	Towels ... doz.	1
Bandages. suspensory ... nos.	4	Twine ... lbs.	½
Binders' Boards ... "	6	Wafers. ½ oz. boxes ... no.	1
Corks ... doz.	4	Wax, Sealing ... sticks	1
Cork-Screws ... "	1	...	...

DUTIES OF ASSISTANT REGIMENTAL SURGEON.—The duties of the assistant regimental surgeon are, in

many respects, similar to those of the surgeon. If he has the confidence of his superior, the patients are equally divided between them; he treating a certain number of sick, ordinarily without interference from the senior surgeon, except they be serious cases, when he seeks advice from the regimental surgeon. Although this is the common course pursued, it is not so from right, but by sufferance of the senior surgeon. In the army regulations, the senior surgeon being the superior officer, the assistant surgeon is under his control. Besides attending to a number of patients, he is expected to make up medicines, and see that the patients get them at the proper time, apply dressings, bandage fractured limbs, keep the register, diet, and prescription books, and assist in compiling the monthly and quarterly returns. When a detachment is sent off upon special service, the assistant surgeon accompanies it as medical officer.

When epidemics occur in camp, then the duties of the medical officers become very arduous; the daily and nightly toil which they are compelled to undergo, the fatigue of body and anxiety of mind which is their daily routine, soon breaks them down, and many an over-zealous surgeon becomes a prey to the diseases which his constant efforts are trying to subdue in others. This is particularly the case when typhus is raging in camp; when a neglect of those hygienic precautions which the medical officers are instilling into the men causes many a victim in the medical ranks. Under such conditions, it becomes as imperatively the duty of the surgeons to take care of themselves as to attend to the sick; for, should they needlessly sacrifice their lives, they may entail severe suffering on their regiments. The Crimean surgeons were severely censured, after spending all

day in the typhus and cholera hospitals, with their tainted atmospheres, for remaining there during the night also, when there was no necessity for it. It was a useless and dangerous imprudence, an exaggeration of duty, which deprives the army of well-informed men, and impairs the utility of the service.

In the Crimea, the surgeons would frequently meet together for scientific conference and for mutual instruction. Here each gave his experience, and compared the results of different methods of treatment. Their meetings always terminated in practising amputations, resections, and the ligation of arteries on the dead subject. The object of this was not only to gain dexterity in the operative manual, but also to find out who were the most skilled, and therefore most worthy of being entrusted with important duties. It is said that the mortality of the army amounted to two hundred per day, which gave ample material for such practice. These meetings were presided over by one of the most distinguished staff surgeons or medical directors, who would often deliver to the society practical lectures upon the treatment of gunshot wounds. This plan might be carried out in all armies, as it must redound to the benefit of both surgeons and patients.

In some of our armies this excellent plan has been adopted—societies in the field having been formed for interchanging views and advancing the general science of military surgery. In Richmond, the chief headquarters of the army, an association of army and navy surgeons has been formed, presided over by the surgeon-general, which has collected within its limits the medical and surgical talent of the Confederacy. At its meetings the important and mooted subjects of military surgery are freely and thoroughly discussed, and

much valuable information elicited. In order to reach the individual experience of army surgeons, questions of special interest are proposed, and disseminated by means of a circular, by the presiding officer, to the medical officers of the army throughout the entire Confederacy, and ample time is given to obtain individual opinions, based upon experience, which are brought forward when these questions are discussed before the association. By adopting this plan the very best results are obtained, and the experience of the medical staff collected.

Duties of the Surgeon on the Battle-field.—The common fear which depresses the soldier on the eve of a battle, more than any other, is not so much death, but the dread of mutilation. Bullets are neither respecters of parts nor persons; and the prospect of losing an eye, an arm, or leg, makes many a brave man quail before the ordeal through which he is to pass. So that, before a battle, there is a vague, uneasy restlessness—a foreboding of coming evil—which takes possession of the bravest, and can not be driven off except by the commencement of the fight. The early booming of cannon braces all for action; all thoughts of fear or self are now discarded, the demon of war rules triumphantly over the assembled host, and suppresses, through thirst for blood and desire for victory, all depressing influences. There is something in the smell of gunpowder which makes men forget their origin; by its magic spell women are made brave, and cowards heroes. In the eagerness of the fray an intoxication guides all to acts of daring. Who, in his sober moments, would walk up to the mouth of a loaded cannon to which a torch is being applied? Yet, on the battle-field find the man who, at the word of

command, and while under the stimulating intoxication from gunpowder, would not face certain destruction! Fortunate it is that nature has so constituted us, or the terror of pursuing a course which duty dictates would be agonizing indeed. The surgeon on the battle-field must participate in the dangers, without the stimulation of the conflict; he requires, therefore, a double proportion of courage to sustain him in the trying part which he has to perform.

Upon the eve of a battle, the regimental surgeon has much to do to prepare facilities for the treatment of the wounded. He must see that the hospital stores are brought up with the ammunition wagons—as the articles for treating the wounded and saving the life of comrades are fully as important as those for the destruction of the enemy. He examines his stores, and satisfies himself that nothing which will be required for the wounded has been omitted or forgotten. He examines his instruments, his supply of bandages, lint,* india-rubber cloth, oiled silk, or waxed cloth, etc.;

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*Carded cotton has been extensively used in military surgery, and was found in the Crimea to be a good substitute for lint by the French surgeons, with whom an abundance of lint is a *sine qua non* in the treatment of wounds. As it can be so easily obtained in any part of the Confederate States, and at so trifling a cost, it promises speedily to usurp the place of the officinal preparation. Now that tents and meshes are scarcely used, and receptacles for collecting pus are denounced in modern surgical practice, we see no reason why carded cotton, with its very soft, elastic fibre, would not make a more soothing dressing than lint, which is often formed of coarse, hard threads, which would leave their marks upon a sensitive, inflamed surface, and, therefore, must be the unrecognized cause of pain.

Mayor, in his work, "*Bandages et Appareil á Pansement*," after mentioning that the use of raw cotton had been proscribed without cause in the treatment of wounds, reiterates what would be evident to every serious investigator, that far from being hurtful, this substance, so light, so soft, so clean, so simple, so abundant, and so easily obtained,

the rule adopted in European armies being, to have ready dressings for one-fifth of the command going into action. He sees that chloroform and opium, or morphine, the chief source of comfort to the wounded, are at hand in sufficient quantity. Water he has not overlooked, as an abundant supply will be needed to meet the incessant, unmitigated thirst of the wounded. He should be well supplied with astringents, of which the perchloride or persulphate of iron is the best to control annoying hemorrhage. He should also have a moderate supply of brandy to revive those exhausted from hemorrhage, oil to grease their wounds, and a

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is the very best article that can be used. All will acknowledge that, for protecting parts from pressure, and for equalizing the pressure of the apparatus, this is the preferable article for many reasons. For the dressing of wounds lint is used, because it is thought soft and soothing to the raw surface—how much better, on this very account, is cotton than the finest lint? If cotton is used, and its claims recognized as an application to the raw, inflamed, sensitive surface of a burn, with how much more reason could it be applied to the comparatively healthy surface of a wound? The best lint is obtained by scratching cloth until it yields a soft down, which, when obtained, is nothing but raw cotton, viz: reducing the cloth to its primitive element. Hereafter there will not be that demand for lint as heretofore; and, in times of war, the female population of a country will not be called upon to use all of their exertions in scraping lint from rags, many of which already contain the germs of disease, when any number of bales of cotton lint can be obtained at once, and at little expense, and without trouble. Female labor has been much more profitably employed, during our struggle for independence. Lint has been but little used, as the cold water application to wounds is the universal treatment in the army, which excludes the use of lint. Many leading army surgeons have discarded lint altogether as an encumbrance to surgical dressings.

Much can also be said of new cloth *versus* the old linen of time-honored reputation. Suffice it to say, in this connection, that an army should never clog its movements by an excess of baggage, and that the old linen (which can be used but once) required for an army is no small item. New cloth can be washed a dozen times, if required, which in itself is no mean recommendation.

little tea, sugar, and such medical comforts as will refresh and support the wounded.

Having selected from the general stock those articles which he will need, such as all articles for dressing, viz: cotton, lint, cloth, bandages, oiled silk, sponges, ligatures, adhesive plaster, splints for treating all varieties of fractures, amputating and dressing instruments, with medicines and stimuli, and a full supply of good water—they are carefully put upon a pack-mule in two strong, iron-bound boxes, called panniers, one hanging on either side of the saddle. One is usually devoted to medicines—the other is used for dressing apparatus. This distribution gives the surgeon great facility in moving about the field to those positions where his services may be most required, while it dispenses with the hospital store wagon, which is altogether too cumbersome to follow light troops in their varied and active movements. In European armies every regiment has such a pannier, which is continually resupplied from the medical store wagons. The commanding general may sometimes have good reasons, under particular circumstances, for ordering the medical wagons to remain behind with the baggage; then some other conveyance for all needful medical supplies for the wounded becomes imperative.

Panniers are used only to a limited extent in our armies, from the scarcity of supply. We are, therefore, forced to use ambulance wagons instead of pack-horses in our rapid movements.

As panniers are sometimes objected to on account of their size, and as modern surgery recognizes but few medicines as really necessary on the field, light leather water-proof cases, which are carried by an orderly, are found preferable. A great convenience to

the surgeon is the modern addition of a hospital knapsack to his equipments, which enables his orderly to carry conveniently, for immediate use, such articles as the attendance upon the sick and wounded require.

The hospital knapsack which has been issued to the Confederate army is framed similarly to the ordinary knapsack, but larger, being sixteen inches long, fourteen inches wide, and six inches deep. The interior is divided by wooden partitions into four compartments, with a broad band of leather tacked across the lower portion of the enclosure to prevent the contents from dropping out. A leather apron, similar to that of an ordinary knapsack, covers the front of the knapsack. The frame is surmounted by a horseman's valise, which is convenient for carrying large bottles, dressings, and instruments.

The hospital knapsack contains the following drugs, viz: tannic acid, 1 oz.; nitrate of silver, fused, ¼ oz.; simple cerate, ½ lb.; chloroform, ¼ lb.; adhesive plaster, 2 yards; isinglass plaster, 2 yards; powdered alum, 2 oz.; aromatic spirits of ammonia, 2 oz.; Hoffman's anodyne, 2 oz.; brandy, 1 bottle; muriate tincture of iron, 4 oz.; laudanum, 4 oz.; paregoric, 4 oz.; comp. cathartic pills, 4 doz.; camphor and opium pills (camphor 2 grains, opium 1 grain each), 4 doz.; opium pills (1 grain each), 2 doz.; acetate of lead and opium pills (lead 2 grains, opium 1 grain each), 2 doz.; and quinine pills (3 grains each), 4 doz. And in a haversack, made of water-proof enamelled cloth, is carried bandages, 6 rolls; sperm candle, 1; lint, ½ lb.; medicine cup, 1; pins, 1 paper; and 2 pieces of sponge. Assistant surgeons should carry a small leather haversack, with a flap cover, to button for security. This will contain his pocket instruments, torsion forceps, light dressings, pins, sponges, etc.

In making the daily rounds of the sick in camp, when they are scattered in their tents and not concentrated within a hospital enclosure, this knapsack, with contents, carried by an orderly or the hospital steward of the regiment, will save much delay and trouble in the dispensing of drugs. When carried on the battle-field many articles may be dispensed with, and in their stead the knapsack should contain lint, bandages, adhesive plaster, sponges, and a bottle of sweet oil, with pins and tape, for the dressing of wounds; a bottle of the perchloride of iron, for controlling hemorrhage; field tourniquets; a bottle of morphine, for allaying pain; chloroform, should an urgent case demand an immediate operation to save life, and a quart or more of brandy; also candles and matches, which are indispensable, as no efficient aid can be given to the wounded upon the field after darkness sets in, without them. The orderly who carries the knapsack also carries, suspended to his person, a large canteen, three times the ordinary size, filled with water, and also a tin cup. The knapsack should be so arranged that all the contents will be exposed to view without unpacking.

If the army would adopt those regulations of the Prussian service which compel every soldier going into battle to carry in his knapsack a small bundle of dressings, prepared according to a formula, then the hospital stores could in a great measure be dispensed with, and with few additions to the individual stock, the wounded could receive careful dressing. The instruments and few medicines which the infirmary would require could then be readily moved from place to place, following the line as the din of battle recedes from the points where the fight had commenced.

The surgeon should examine the means of transporting the wounded from where they fall to the field infirmary. These should consist of at least two stretchers for every one hundred men engaged, although in European armies four are allowed to each company, besides light ambulance wagons, spring-carts, or any other conveyance of transportation, to accommodate in the proportion of forty persons for every one thousand troops. The allowance of ambulance transportation in the Confederate service is for twenty lying and twenty sitting per one thousand men, added to which are five litters to each regiment.

The character of the transport service will depend upon the character of the country in which the war is carried on. In a level country, wagons are the most serviceable; while in hilly localities, litters carried by mules would be the most comfortable transportation for the wounded. In Confederate as in European armies, a distinct body of men are employed for conveying the wounded, so that practised hands may soothe the agonies of transportation. This is by far the most humane course, and, as a mark of civilized warfare, should be of universal adoption. It is highly important that a similar body be instructed to act as nurses as well as attend immediately upon the wounded, as this timely assistance may save many lives on the field. In those armies in which this ambulance corps has not yet been introduced, the regimental quartermaster, in charge of the pioneers and musicians, form a temporary body of carriers. Besides the litters, each bearer carries a canteen full of water, and the assistant surgeon, who follows the litters and directs the transportation, is accompanied by two men as orderlies. One of these orderlies, who habitually follows the medical officer,

whether in battle or on the march, carries the hospital knapsack. One of the orderlies is armed, to protect the party against stragglers and marauders. The surgeon, for a similar reason, should be also armed with a revolver. The orderlies assist the surgeon in placing the wounded carefully in the wagons; and also following them, are at hand to assist in unloading the wagons at the field infirmary.

When the troops deploy or form for action, the surgeons, with their assistants and pack-horses, move a short distance to the rear, out of the range of the shot, and they establish there the field infirmary. It would be convenient if some house could be used for this temporary hospital.

Where this can not be had, the shade of trees or the shelter of a hill-side will answer the temporary wants of the surgeon. If the body of troops about entering into battle is a large one, with an extended line, several of these points should be selected and marked by a suitable red flag, which designates the spot where those slightly wounded can seek surgical aid. These locations should be selected as near as possible to the line of battle, so that they may be easily reached by the wounded. They should be readily recognized, protected from the enemy's fire, well supplied with water, and, if possible, with straw and shelter for the wounded. These sites should be known to the commanding officer, so that he might extend his orders to the infirmary, should it be necessary, during the fight.

Before the medical army staff was properly organized, and their plan of work studied, so as to render the staff most efficient, surgeons accompanied the troops into the fire, and took position along the line of battle, where they could give immediate succor to

the wounded. Experience showed them that, thus isolated from each other, and having no means of carrying with them the various instruments which they would require, it was impossible to perform any but the most trivial operations; hence the necessity of assembling surgeons together at the various field infirmaries, where, by assisting each other, all the necessary operations may be successfully undertaken Instead of each regimental surgeon establishing such an operating site for his regiment, the plan which is now adopted in the Confederate service, and which has decided advantages, is to establish a division or corps field infirmary, at which all the surgeons of the division or corps concentrate. The advantages of this concentration are that medical officers can always be found by their commanders, and can assist each other in the care of the wounded. It often happens that but a portion of the opposing troops are actually engaged in the fight. Under the old plan of regimental infirmaries, the two medical officers of the regiment engaged would have more to do than they could possibly attend to—the wounded remaining unattended for hours—while medical officers of regiments not in the fight would be idle. Now, by concentration and mutual assistance, the wounded can be attended to as rapidly as they are brought in. The division or corps surgeon establishes and directs the surgical affairs of the field infirmary, and the ambulances of the division are also concentrated at this point, and thus offer great facilities for removing rapidly the wounded, as soon as their wounds are examined, to positions in the rear.

When surgeons combine at the field infirmaries, the usual course is to be operator and assistant in turn—relieving each other when fatigued. It would be far

better, however, to establish at once, if possible, a division of labor; let there be an understanding that those best adapted by experience to undertake certain duties, should confine themselves strictly to the same. When each one knows what *rôle* he is to play, and does not interfere with others, a great deal more work can be accomplished than where each one acts independently for himself. The force of this will appear, when it is remembered that all experience shows the medical staff of an army, however numerous, to be always too few on battle days. *Remember, that all the wounded must undergo a thorough examination, and all needful operations should be performed within twenty-four hours*, or the wounded suffer from the neglect. Now, take into consideration the very small surgical staff of our army, and the accuracy of fire of the contestants, with the most approved and destructive arms with very long range, and we will immediately see the necessity of economizing time and labor.

Moreover, among the officers of every brigade are found surgeons of experience and judgment, but among them are also men of purely theoretical knowledge, just from the schools, who always exhibit an eager desire to use the knife, without the judgment and experience necessary for deciding when operations are required. Such officers can be heard boasting of the number of operations which they have performed, rather than the number of cures which they had obtained. Many a limb has been sacrificed to this inordinate thirst for operating, as many a brave and stalwart soldier reports the safety of a useful limb to his own resistance to such indiscriminate mutilation. Such surgeons require restraint. After every encounter the cases for legitimate operation are, unfortunately, so numerous that even the most

ambitious can, in time, have their desire for operating satisfied. The judgment of such officers should be guided by the experience of others; and hence the useful division of labor at the field infirmaries, into those who examine wounds and determine the general course of treatment required, and those who perform such operations as, in the experience of the board of examiners, are necessary for the safety of the wounded.

The movements and position of the troops, and the character of the ground, must establish the necessity for the greater or less concentration of surgeons at the field infirmaries. As the troops advance, they are followed by the bandsmen or litter-bearers, and, if the country permits it, the ambulance wagons, under charge of the quartermaster and assistant surgeon, accompanied by his orderlies. These station themselves in the rear of the advancing line, where they can distinctly see what happens, and remove immediately, without the range of the shot, those who may fall wounded. It is imperatively demanded, on the score of humanity, that the wounded be removed from the field of battle, with as little delay as possible, for early treatment. In gunshot wounds, above all others, to obtain success early surgical assistance is of the greatest moment. Therein is the great advantage of having a special transport corps—otherwise the excitement of battle, or the eagerness of pursuit, carries the line to a distance from the ground where the battle first commenced; and it is only after the victory is achieved that the wounded are thought of by their comrades, who, in scouring the field, find many a dear friend whose life has paid the forfeit of delay.

The practice, too frequent in our service, of taking off the surgeon of a regiment with a wounded officer,

and leaving the command exposed to fire without competent surgical aid, is an abuse of authority which can not be too severely denounced; and any officer should be severely censured who, from selfish motives, would allow his command to be thus exposed. Another act for censure, which should render a surgeon liable to court-martial for dereliction of duty, is in so far forgetting his position as to assume the offensive, and enter pell-mell into the fight. The temptation is strong; but among the first lessons to be learned by a military surgeon is that of self-restraint and rigid attention to those duties which are connected with his position. His duties lie with the wounded, and not in the charge. The comfort, if not the lives, of many are in his keeping, and all unnecessary exposure which he voluntarily incurs can but be detrimental to the service. In the early campaigns of the war, surgeons under fire often forgot their positions and responsibilities by entering into the fight. A more wholesome discipline has altogether corrected this evil.

When our troops remain in possession of the field, the enemy having fallen back, the surgeons attached to the ambulance corps should proceed without delay to the front of the line, with all possible means of transportation, to collect the wounded; and as most frequently night has set in before the enemy has yielded, torches should be carried by the hospital or ambulance corps, to facilitate this important and humane search, which is too frequently neglected.

When our army retreats and our wounded have to be left, some of our surgeons should be left in attendance, and supplied with necessary dressings—as no dependence should be placed upon the medical stores of the enemy, which may be exhausted, or be of an inferior quality.

CHAPTER V.

TREATMENT OF GUNSHOT WOUNDS—WHAT SHOULD BE DONE ON THE FIELD BY THE ASSISTANT SURGEON IN COMMAND OF THE LITTERS—THE TREATMENT AT THE FIELD INFIRMARY—HOW WOUNDS SHOULD BE EXAMINED.

When a soldier falls or is wounded in battle, he is at once conveyed by the litter-carriers from the line of battle to a short distance in the rear, where the assistant surgeon looks at his wounds, applies the hasty dressing which they require, and, placing him comfortably on the litter, attends to his transportation. He can do as much for the wounded in this way as if he were actively engaged in operating. Should the injury permit the wounded man to walk, a compress and bandage is placed upon his wounds, if they be severe, and he is directed to the field infirmary. In, however, by far the majority of cases of flesh wounds from rifle or musket balls, no dressings are applied by the surgeon of the ambulance corps. The wound does not bleed much, and the dressings would necessarily be so hastily put on and again removed at the field infirmary, that much saving of time and material is effected by sending such cases directly to the infirmary for careful examination and appropriate dressing. In those with fractured limbs, a rapid glance, quick intelligence, and an inventive turn, at once tells the surgeon what is required, and suggests the means of effecting it. With a sword-blade, a ramrod, or a bayonet, with a handkerchief or strip of cloth, a fracture apparatus is at once improvised, and the thanks of the wounded, now in comparative comfort, are

freely bestowed during his transportation to the infirmary or general hospital. If he has a mangled limb, which hangs by a very small portion of the soft parts, its separation should be at once effected by cutting through the mangled tissues. Should he be suffering much pain, which is not usually the case, the surgeon, whose pockets are well stored with morphine, gives him an anodyne powder, and at once transports him to the infirmary, where the necessary operation is performed. If the wound be an abdominal one, with protrusion of the intestines, he sees whether the bowel is injured or not. If not injured, he returns it carefully within the abdomen, and gives a large dose of morphine to ensure quiet. Should the intestine be cut by the ball, he warns the carriers and assistants from interfering until the wounded man be carefully transported to the infirmary. Those wounded in the head, if insensible, require very careful transportation; they should be as little disturbed as possible. Fractured legs give the most trouble in transporting from the field, as they require the greatest care in conveying them safely to the designated places for surgical treatment.

It is seen, from this rapid sketch, that the surgeon who follows the troops into action has nothing to do with amputations, resections, extracting foreign bodies, etc.; these form no portion of his duties. His province is solely to prepare the wounded for successful transportation, and beyond this he should not intrude his attentions. The great perfection of rifled weapons has its influence upon the duties of the field surgeon, as the rapid and frequent changes of the battle-field threaten to restrict, within very narrow limits, field surgery with the ambulance corps, and necessitate very hasty dressing.

An eminent military surgeon—Mr. Guthrie—states that bandages applied on the field of battle are, in general, so many things wasted, as they become dirty and stiff, and are usually cut away and destroyed without having been really useful. There is much truth in this statement. Much of the hasty dressing by the transport surgeon can very well be dispensed with. As he has neither the time, nor is it his duty, to examine carefully the wounds, most of the wounded might be sent on directly to the field infirmary without dressing. The dressings, when removed at the field infirmary, are so soiled that they are thrown away. Time, which is so valuable, and also material, which is never in excess, but most frequently deficient, can be saved by adopting this course. Only in cases of active hemorrhage would it be necessary to apply compresses and the roller-bandage, or, what is more rarely required, the tourniquet. Let all other cases of flesh wounds receive their first dressing at the field infirmary.

Should the soldier have a large artery wounded, and the hemorrhage be excessive, which is but seldom the case, the surgeon should instruct the orderly who superintends his transportation how to make judicious finger-pressure. This is much better than the tourniquet, producing much less engorgement of the injured tissues.

Field surgery, properly speaking, commences at the field infirmary. Here all wounds are thoroughly examined, and an accurate diagnosis established. The wounds are thoroughly cleansed; all foreign bodies which can be, are removed, and the first dressing made. If the wounds are trivial, they are dressed, and the men sent to rejoin their companies.

When the wounds are quite recent, before the tis-

sues become engorged, there is a temporary absence of pain and a relaxation of the injured parts, which favor an examination. The wound should now be examined throughout its entire extent to determine the presence of foreign bodies, whether they be balls, wadding, portions of clothing, detached spiculæ of bone, etc. *For this purpose the finger is the proper probe*, and should be used on all occasions, with rare exceptions. It is an intelligent instrument, and, appreciating what it feels, it will not only discover the character of foreign bodies complicating the canal, but will avoid increasing the dangers by making new lesions in the depth of the wound. In fresh gunshot wounds the apertures which the balls make are large enough to admit readily the finger when introduced with care, as the balls now used in warfare are of greater diameter than the finger. Very rarely is it necessary to dilate a wound with the probe-pointed bistoury to assist in its exploration. *The silver probe is a dangerous and deceptive instrument, and should be discarded from the battle-field.* Its use on such occasions, for exploring recent wounds, marks the novice.

Balls are readily detected in a fresh wound, by placing the patient in the position in which he received the injury, if the direction from which the ball came be known. Portions of clothing and wadding are detected with greater difficulty. Before, however, probing the wound for the detection of foreign bodies, be quite sure that the clothing of the soldier has been perforated. Often a single orifice is seen leading into a limb without exit, which would at once suggest an embedded ball; when an examination of the clothing would show that the ball had driven these into the wound without sufficient force to transfix them, and, on removing hastily the clothing, the

ball had been extracted by this diverticulum pushed in before it. This examination of the clothing will save much time to the surgeon, and painful, protracted, injurious probing to the wounded.

Among the wounded Federalists from the Battle of Manassas in the general hospital at Richmond, a case came under my observation which well exemplified the necessity of observing this rule. It was that of a German who had been shot in the head, over the left parietal bone. As the scalp was wounded and the bones crushed, the escape of fragments during the treatment left an opening through which the pulsations of the brain could be readily discerned. As there was no counter-opening, the conclusion was entertained that the ball had entered the skull, and was now lying embedded in some portion of the brain. The case was exhibited as one of those rare instances in which a foreign body could remain in contact with the brain without producing cerebral disturbance. It was not until some weeks after admission that his cap was examined, when it was found indented and stiffened with blood, showing that it had been pushed into the wound before the ball. The cap had been slightly cut by the sharp edge of bone from the pressure of the ball, but there was no opening sufficiently large to permit a ball to pass. An earlier examination of the cap would have robbed the case of much of its interest.

When the shirt or drawers are not torn, no foreign body can have lodged in the flesh which they were covering. From the nature of recent wounds, the examination and removal of all foreign bodies will be more easily accomplished, and with less pain and danger to the wounded, when undertaken at an early period. This should be done carefully, thoroughly, and without delay.

A regular report should be kept of all the cases dressed at the field infirmary, and a brief description of each case should be sent on with the patient to the general hospital; so that if proper officers, in whose judgment the hospital staff can confide, had previously examined thoroughly the wound and sent on their report, no further examination would be needed. The pinning a paper to the coat of the wounded when he is conveyed from the infirmary, upon which is written the history of the wound, saves time and trouble at the regular hospital, and relieves the patient from much unnecessary pain. *If the surgeon be trustworthy, his diagnosis should be respected, and no further investigation permitted.* Many serious cases can be protected from annoyance and further injury by adopting this simple expedient. In many cases this is the only examination which the wound will need.

The neglect or insufficiency of the first examination is often the after-cause of the loss of a limb, and even life. After-examinations heighten irritation and inflammation in the wound, and, as they permit air (which ought to be rigorously excluded) to pass to the bottom of the wound, this promotes the decomposition of the extravasated fluids and exudations, induces suppuration and sloughing, and predisposes to pyæmia, with its fatal sequelæ. Many a limb and life would be preserved, if the examination of gunshot wounds could be limited to the battle-field; and military surgery will have attained great perfection when a thorough diagnosis is obtained by this first examination.

The extent and nature of gunshot wounds are often ascertained at a glance. Touching a limb may be sufficient to indicate to the experienced surgeon the extent and character of the wound, and suggest the appropriate treatment; while other wounds, as those in

the neighborhood of joints, may require all the skill and scrutiny of the most experienced to obtain a satisfactory diagnosis. No haste should be permitted in this examination, to the injury of the wounded, through a carelessness of diagnosis. *Should large arteries be injured, they should be ligated always in situ above and below the point injured*, and for this purpose the wound must be enlarged.

As a general rule, torn tissues will reunite, while bruised, crushed tissues slough. All wounds in which a probability exists of union by the first intention, should be nicely adjusted by adhesive plaster. The great inconvenience of the ordinary diachylon plaster, which requires heat to make it adhere, must exclude it from field service. The Husband's, or isinglass plaster, is much more easily applied, requires no heat—a little moisture being all that is needed—is not injured by hot weather, and when closing a wound, gives as much support as the diachylon. It also excludes completely the air, with its injurious influences, which is not its least advantage. Diachylon plaster is rather required for hospital practice, where it is used to dress suppurating stumps, from which the continued discharge of pus would loosen strips of isinglass plaster.

Should a limb be so injured that joints are largely opened into, main blood-vessels and nerves torn through, soft parts extensively lacerated, or a limb flayed, then amputation should follow immediately the condemnation of the limb; field surgery here proves itself the only successful surgery, as all statistics clearly show. If the limb is simply fractured, without injury to the main blood-vessels and nerves, and without complications with joint injuries, they should be considered simple fractures, and dressed as such at the field infirmary. If, in connection with a condemned

limb, other mortal injuries exist, the impropriety of performing an amputation is clearly seen, and surgeons must not be seduced from this course by fondness for operating. When joints are crushed, or the heads of bones perforated, resections are urgently demanded, and should be performed before violent reaction takes place.

It is, of course, understood that, although wounds might be examined, foreign bodies removed, and the wound, if simple, dressed while a soldier is suffering under shock, no serious operation, which would still further depress the nervous powers, or cause a further loss of blood, should be performed until extreme depression subsides. Although the nervous shock accompanies the most serious wounds, it may often be met with in the most trivial injuries. It is recognized by the sufferer becoming cold, faint, and pale, with the surface bedewed with a cold sweat. The pulse is small and flickering; anxiety and mental depression is also present, with, at times, incoherence of speech. Often this shock is very transient when accompanying simple wounds. A drink of water and a few encouraging words may be sufficient to dispel it. When it persists, even where the injury appears trivial, it forebodes trouble, and a more careful examination may detect a fatal injury. It is the duration, more than the degree of shock, which marks the serious character of the wound; and when this constitutional alarm persists, there is great fear that hidden mischief is lurking, and the surgeon should be very guarded in his opinion of the case. Keeping the patient warm, in the recumbent posture, with blankets and hot bottles, administering wine, brandy, whiskey, or ammonia, hartshorn to the nostrils, frictions and cataplasms to the extremities, is the course pursued to restore nervous energy.

In all painful operations chloroform should be freely administered to produce the desired anæsthesia. Like all valuable medicinal agents which, when taken in overdoses, are poisonous, it can remove suffering or destroy life according to its administration. The Crimean, Italian, and Confederate wars, in recording the advantages of chloroform in field surgery, show it to be now one of the indispensables for successful practice. It saves the lives of many wounded, who would perish from the shock of a second operation; and also many who would have been considered as without the pale of surgical art can now, thanks to this invaluable remedy, be benefited by surgery.

In our country railroads traverse every portion of the states, and as battles usually occur in the immediate neighborhood of thoroughfares between large cities, it is not improbable that they will be found in the immediate vicinity of battle-fields. If such be the case, a sufficient number of cars should be kept in readiness for the use of the wounded. Transport wagons are in constant communication with the field infirmaries. As the wounded are attended to, they should not be allowed to accumulate around the infirmary, but be sent off at once to the nearest railroad station, from whence they will be distributed in the towns nearest to the scene of action. General hospitals should have been previously prepared in these localities for the reception of the wounded; and here the regular treatment commences.

During a general engagement each field infirmary should be in constant communication with this general temporary hospital which the medical director has located, and as soon as the wounded are examined and dressed, they should be sent without delay to this point. This allows the field infirmary to change its

position, and to follow the division to which it is attached. If this transportation of the wounded be properly attended to, no wounded should be left by night at the field infirmaries.

By not allowing an accumulation of wounded at field infirmaries we avoid confusion, and prevent our men from being made prisoners, should there be a reverse of our arms and an advance of the enemy upon the site of our field hospitals. Should the ambulance wagons not be sufficient to transport the wounded, wagons, carts, carriages, and, in fact, every species of vehicle, should be impressed from the neighboring inhabitants, so as to ensure for the wounded a place of safety and comfort.

If it be convenient for the wounded to reach the general hospital within twenty-four hours from the reception of their injuries, many serious cases for operation, such as the resections, might well be deferred from the field infirmaries until the wounded have arrived at the station where that quiet and rest, with medical comforts, which are so necessary for a successful result, can be obtained. When the wounded are brought to the field infirmary they are not attended to in the order in which they arrive. Those most seriously injured always receive the earliest attention, officers and soldiers awaiting their turn. If the trivial accidents had been dressed upon the field, they should pass directly on toward the railroad or the general hospital, without stopping at the field infirmary.

The common dressings which all gunshot wounds receive is a wet cloth, covered, if possible, with a piece of oiled silk or waxed cloth, and secured with a single turn of the roll of bandage. This keeps the wound moist, and is the most soothing, comfortable, efficient, and simple dressing which can be devised. By wet-

ting the outer bandage, the cold produced by evaporation is transmitted through to the wound, while the oiled silk keeps the parts moist. When oiled or india-rubber cloth can not be obtained, and no facilities exist for keeping the wound constantly wet while the patient is being transported to the general hospital, a cloth well greased with olive oil is the best substitute for the wet dressings. Many ragged wounds may have their edges pared off and then brought together, with every prospect of a speedy union, provided the after-treatment with cold dressings is judiciously followed.

It is understood that all those who can be conveniently moved, should be transported at the earliest possible moment to general hospitals, established in contiguous towns. Should there be no facilities for this transportation, or the serious character of the wound render transportation dangerous, then any house in the neighborhood contiguous to the battle-field must be used as a temporary hospital for the treatment of such seriously wounded, whose safety depends upon absolute quiet, rest, and careful nursing; or tents can be pitched for the temporary accommodation of such patients.

Should the army advance, the regimental surgeons must follow their commands, leaving either an assistant or an extra medical attendant for the wounded—it being presumed that a reserve medical corps had been attached to the army for extra or reserved duty, when it was known at head-quarters that a battle was expected. These reserve surgeons will make every preparation for the comfort and accommodation of the wounded. Should the army unfortunately meet with a reverse, all available means of transportation must be pressed into the service for the removal of the

wounded to the rear, and they must be sent off as speedily as possible. If this had been attended to from the commencement of the engagement, there would be fewer to remove later in the day, when a retreat was compulsory. No wounded soldier, whose injuries are so slight that he can walk, should ever be carried, as he takes up a place in the transport wagon which excludes one who can not assist himself.

There are many cases of injury to which long transportation would be certain death. If the general hospital can not be conveniently reached, such cases must be treated at some farm-house contiguous to the field of battle; and if troops are compelled to retreat, humanity dictates that the severely wounded should always be left to the enemy, with a sufficient number of surgeons and competent nurses to look after their wants. When left without surgeons, they are always neglected, and many lives may be sacrificed for want of that immediate attention which the enemy's surgeons must first give to their own wounded, and which precious time can never be recovered. This becomes especially urgent where the nations at war speak different languages. The rule now recognized in civilized warfare is, always to leave competent surgeons with the wounded who are left to be cared for by the enemy. Such surgeons and nurses being always considered as non-combatants by a civilized enemy, are allowed to return to their corps as soon as their services can be dispensed with, without detriment to the wounded prisoners.

The following excellent advice is offered by Dr. Millengen to surgeons who may be placed in such trying conditions: "When surgeons are thus placed on duty with an enemy, they must bear in mind that the welfare of our wounded will, in a great degree, depend

upon the propriety of their conduct. No irritation of mind from disappointment, no national feeling, should induce them to enter into unpleasant discussions. They should especially endeavor to cultivate a friendly intercourse with their medical brethren, carefully avoiding altercations on professional points, in which most probably they may differ. A deviation from this prudential course has often proved the source of jealousies and animosities, from which the wounded ultimately suffered. When the enemy's wounded are numerous, and their surgeons are not in sufficient numbers to attend to them, we shoald invariably volunteer our assistance, should our duties afford us leisure. Such a line of conduct is ever appreciated, and can not fail to lead to ultimate reciprocal advantages and good feeling."*

*Article Ambulance, in Costello's Cyclopædia of Practical Surgery.

CHAPTER VI.

The character of Gunshot Wounds—Orifices of entrance and exit—Primary Hemorrhage—Natural Hæmatosis—Tourniquets but seldom required in Surgery—How Hemorrhage controlled—Examination of Wound for Foreign Bodies should only be done once, but that thoroughly and as soon as possible after the Accident—The History of the Case important—Lodging Foreign Bodies always give trouble, even years after injury—Gunshot Wounds do not require Dilatation—Necessity of Examining the Pulsations of the Main Artery below the Wound for suspected injury—Ligation of the open Mouths of the Artery the Rule of Practice—Water-dressing the only rational Treatment of Gunshot Wounds; its advantages over all other applications—Secondary Hemorrhage, how treated—General or Constitutional Treatment of Gunshot Wounds.

Appearance of Gunshot Wounds.—We have already stated that the more perfect and destructive arms now in use in modern warfare, and the variety, form, and size of missiles, have modified materially the symptoms and march of gunshot wounds. From the effects of a cannon shot weighing six hundred pounds to the ounce ball of an Enfield rifle, a small fragment of shell, or still smaller buckshot that enters into the musket cartridge, we see every possible variety of wounds, both as to extent and severity, although the cases of gunshot injury requiring treatment are usually from rifle or musket balls, or small fragments of shell.

Large round cannon ball have nearly been discarded from modern warfare, and the pyramidal piles which formerly graced all arsenals have now given

place to elongated shot and bolts of three times the former weight of metal, which are ejected from rifled cannon with frightful velocity and wonderful precision, when even at a distance of nearly five miles. When these huge missiles strike the trunk they cut the body in two, and when they impinge upon a limb they sweep all resisting tissues before them in their onward career, leaving an irregular, blackened pulpified stump, in which detritus of bones and muscle, with coagulated blood, form an amalgam of lifeless tissue, which the surgeon must remove by amputation. The torn blood-vessels, however large, do not usually bleed in such a stump. A spent ball of heavy weight will disorganize the subcutaneous tissues, crushing the bones, although the tough elastic skin may remain unbroken. Extensive echimosis appearing after a few hours, indicates the severity of the injury.

Fragments of shell from ten and twenty pounder guns, which are the calibre of field-pieces, make very ugly wounds; and where they do not impinge against bones, tear down the tissues, leaving extensive suppurating surfaces which heal very slowly. When they bury themselves in a limb, the wound which they make is irregular, often elongated, and usually smaller than the diameter of the fragment embedded.

The conical shot, with its excessive momentum, transfixes the tissues with great rapidity, usually passing directly through the soft parts, rarely burying themselves, and when not impeded in their transit by very resisting media, the two orifices of entrance and exit which they leave vary but slightly in their appearances.

The entrance made by a conical ball in the skin is more or less oval, depending upon the contraction and retraction of the skin, and sometimes, although rarely,

it presents even a linear appearance resembling an incised wound. When the conical ball, entering point foremost, and meeting some resistance in its course through the tissues, is either changed in form or is turned upon its side, the orifice of exit is found very large and irregularly torn, with the surrounding tissues much bruised.

Balls, whether round or elongated, usually make an irregularly rounded entrance, surrounded by discolored, depressed, inverted tissues—these having been evidently mashed or crushed by the ball prior to its entrance, and the skin drawn in to a certain extent with it. When the ball is moving with great velocity the orifice of entrance may be more or less round, with loss of skin, and the edges smoothly cut, without depression or inversion of its margins. The tissues around the orifice of exit are lacerated, usually more or less protruding, and the orifice probably larger, and more irregular than where the ball entered. These two orifices are, however, modified in appearance by so many circumstances—the form, size, velocity, and number of the missiles; changes in the missile after its entrance into the body and prior to its escape; the distance of the wounded person, his position, his clothing, foreign bodies which may have been about his person, and driven before the ball, etc.,—that in some cases, without the history of the accident from the patient or those who saw the occurrence, it would be difficult to determine which opening was first made.

The effects produced by the action of the ball upon the two orifices can be easily understood when it is remembered that, in entering, the tissues which are being perforated are supported by the entire thickness of the limb, so that often the ball appears to have carried before it a piece of flesh which it had cut out

as by a die, and hence the more or less rounded form of this opening. After traversing the limb, in making its exit, the tissues through which the ball is now pushing have no support. They are stretched inordinately before they are torn, hence the eversion of the edges and the flap-like lacerations of this exit, with sometimes nothing more than a rent or split in the skin. Observing field surgeons have noticed that, in examining recent wounds, the finger in passing through the orifice of entrance traverses a comparatively smooth channel in the same direction with the inverted tissues. When the finger, on the contrary, is thrust in at the orifice of exit, a sensation of roughness is experienced as the ends of the inverted tissues are encountered. The direction of these inverted tissues, like splinters of wood, all running one way, can, by careful manipulation, be used in recent wounds to assist in establishing a diagnosis. Engorgement of the tissues will mask, and suppuration completely efface, all traces of direction of the soft filaments. If a bone has been shattered, the direction of the spiculæ will always determine the direction of the missile, as they are invariably driven in front of the ball. All who are familiar with the driving of a nail through a board, or firing at the same with a pistol, will see a rough working of this principle. These peculiarities are, at times, so stamped upon the clothing that, by an examination of them alone, a diagnosis can be established.

It is often of consequence to determine the character of these apertures, so as to distinguish between a traversed ball, with its two orifices, or two balls embedded. It must not be forgotten that one ball may make several openings, by the ball being divided in the limb upon a sharp crest of bone. Cases are not

very rare in which a portion of a ball may pass out, a fragment remaining behind. A single ball, by splitting in this way against some obstacle in the flesh, has been known to break into six pieces, each in exit making a corresponding wound.

In removing balls, whether conical or round, from a limb, most frequently indentations are seen upon their flattened sides—imprints of the opposing tissues which had offered the greatest resistance to their onward progress. Very often are such balls irregularly mashed, and sometimes completely flattened, as if beaten out by heavy blows between two hard plates. When impinging against an osseous spine, or even a tendon, I have seen a ball which presented the appearance as if a wedged-shape piece, involving one-fifth of its substance, had been cut out by some smooth, sharp instrument; and I have also seen balls completely divided by meeting a similar obstacle. It has been the habit to account for these changes in form and the mashing of balls by their striking upon some hard, resisting body before entering the tissues—as a tree, a wall, the gun of a neighboring comrade, etc.; but very frequently we remove flattened balls from persons when no such explanation can be accepted. In these cases we are forced to seek other causes for this flattening of the missile, which we can only explain by an increased temperature in the ball, the result of friction and heat transmitted from the ignited charge, which renders the metal so malleable as to receive impressions from comparatively soft bodies. Those who have observed the moulding of bullets must often have been struck with the little force requisite to cut off the necks of a dozen at a time while warm in the moulds. But let the ball cool, and the separation of a single neck of lead from the round mass becomes a serious un-

dertaking, requiring a very heavy blow. May not this increased temperature of a ball also explain other phenomena connected with gunshot wounds, viz: the burning sensation imparted by a ball traversing the tissues, the sensitive nerves magnifying its temperature, etc.?

Conical balls show much less deviation than round balls. They usually take a straight course, ploughing through all opposing structures—nothing resisting the penetrating force of these projectiles. They seldom follow the contour of bones, as the round often do, but at once crush them—their double weight and increased velocity making many more fractures than the round ball of former wars. This perforating property of conical-cylindrical balls, which is now the common form of rifle missile, depends more upon its momentum than its shape, which, when placed under the same condition with a round ball, would be even more likely to be diverted from a straight course by resisting media. This divergence of conical shot is strikingly exemplified in ricochet firing over water. The heavy conical shot are found to be so readily diverted as to destroy the efficacy of ricochet firing, which, with round ball, is very destructive. On this account elongated conical balls, from rifle cannon, are only effective when fired directly at an object. When conical balls are carelessly made, they assume every possible position in their flight, and when fired at a target are found to strike with their side as often as with the point.

In spite of the rapid passage of even conical balls, some of the tissues, through their toughness and elasticity, often escape direct injury from them. Arteries come under this head. Owing to their peculiar structure, cylindrical form, and loose connections, lying in

a bed of very loose, cellular tissue, which permits of considerable movement, they often escape transfixion, when their position lies evidently in the direct course of the ball. Every army surgeon has seen numerous cases of gunshot injuries about the root of the neck, where balls had traversed, in every conceivable direction; in some cases antero-posteriorily—in others laterally—going deeply through the soft parts, yet picking their way, as it were, with such care as to avoid the great vessels among which the missile had channelled its course. So great is this power of avoiding perforation in the large arteries, that rarely does death take place on the battle-field from division of the large vessels of the extremities by bullets.

PHENOMENA ACCOMPANYING GUNSHOT WOUNDS.—It has often been noticed by hospital surgeons that, under treatment, wounds from certain battle-fields assume peculiar phases, which, at other times and under other circumstances, they do not exhibit. I have often heard it remarked by army surgeons that the wounds from the several battles before Richmond, viz: those of the 26th, 27th, 29th, and 30th of June, and 1st of July—exhibited a marked disposition to slough; while those from other battle-fields would heal up with great readiness, the majority of those sent into hospitals not being retained more than a few days. This condition of sloughing, with its direful accompaniments of secondary hemorrhage, etc., can be traced to the combined effects of many depressing causes. In those wounded during the battles about Richmond, we find a ready solution in the bad condition of the troops, owing to the enervating influences of camp diseases, viz: measles, typhus, and malarial fevers, etc.; added to which, our troops were very badly clothed and badly

fed, often subsisting upon one-quarter rations; the weather very inclement, with continued rains; and our troops morally depressed, by being forced back by overwhelming numbers to cover their capital; and, crowning all, the exhausting fatigue of fighting day and night for six consecutive days, pressing the enemy continually forward, and encountering him successfully in five severe battles. This combination of depressing causes had a very marked effect upon the recuperative powers of our wounded men, and cases of profuse suppuration, with pyæmia, erysipelas, hospital gangrene, etc., filled the hospitals.

A certain amount of hemorrhage always accompanies gunshot wounds; but, owing to the irregularity and the asperities of the sides of the wound favoring the clotting of blood, we usually find that the external flow, however excessive it may be for a short time, soon ceases, while concealed hemorrhage, to a limited extent, extravasates blood into the surrounding tissues. When the divided blood-vessels are so closed that the blood-cells can no longer escape, serous oozing still goes on, increasing the infiltration. These are the causes of the rapid swelling which follows gunshot wounds. When arteries of considerable size are not injured in the passage of a ball, a very characteristic appearance in gunshot wounds is the dryness of such when contrasted with wounds produced from other causes. This dryness depends upon the laceration of the tissues, assisted perhaps by an excited action in the divided vessels, from the application of the heated ball in transit—which, although it has not a sufficient elevation of temperature to sear the tissues, would, nevertheless, stimulate the small vessels to contraction, even to the closure of their divided mouths. Those arteries which are divided by a ball in rapid motion will bleed

more than those injured by a slow or spent ball, and large vessels, when injured, will, of course, bleed more profusely than the smaller ones, and the hemorrhage from those partially divided is always excessive.

The pain which accompanies the reception of gunshot injuries is often so trivial, that the attention of the wounded is only called to the fact by blood streaming down the limb. McLeod mentions the case of an officer who had both of his legs carried away, and experienced so little pain that he only became aware of the injury which he had received when he attempted to rise. The majority liken the striking of a ball to a smart blow with a supple walking-cane, or a sensation of heat through the part struck; while with a few the pain is very severe, and simulates the feeling which would be produced by running a red-hot wire through the flesh.

It appears that every gunshot wound is accompanied by a certain amount of shock, which in some would be scarcely perceptible, but in many is well defined, and in serious cases of wounds very persistent. Immediately upon the receipt of injury, the features of the patient may indicate alarm. His face indicates anxiety and distress. He looks pale, with colorless lips; feels cold, trembles, and complains of feeling faint, with perhaps sickness of stomach and vomiting. His pulse is feeble and quick, respiration irregular, and interrupted with sighs; his skin cold and moist, sometimes wet with a clammy perspiration; the features seeming to shrink from the contraction of the blood-vessels, which are comparatively emptied of blood. Whether this general shock be marked or not, there is in all gunshot wounds, immediately after their reception, a local shock or partial paralysis of sensation—a numbness, which is nature's preparation, permitting a thor-

ough examination with little or no pain. The unusual quiet of a hospital the night following a battle has been repeatedly noticed, and is accounted for by this nervous shock. When this condition passes off, then reaction brings with it much suffering. In this nervous shock, with the suspension of activity in the circulatory function, lies the safety of many a wounded soldier. Its influence is immediately felt in the injured tissues. As the heart's action is controlled and the pulse very feeble, the vessels are not distended with blood, and the infiltration and engorgement of the tissues are prevented. When nervous depression exists, but little blood escapes from the injured vessels; and as there is no force from behind, owing to the diminished action of the heart, to drive on and keep in motion this blood, its clotting is favored. Before reaction ensues, the clot has had time to form and to solidify, and has become so firmly established that it can not be displaced. By the addition of a fibrinous secretion from the capillaries, the injured vessels remain thoroughly and permanently plugged up, and the dangers from immediate hemorrhage are prevented. Shock may accompany a very slight injury, and may exhibit itself in the most courageous and intelligent, so that it can not always be attributed to alarm. On the other hand, a very severe wound may be unaccompanied by any perceptible agitation.

The duration of this shock is very variable—lasting but a few minutes in most instances, and passing away without medical assistance; in other cases persisting, nothwithstanding the internal use of stimuli and external application of warmth combined with stimulating remedies.

When shock exists we try to ascertain the cause, which a glance at the position of the wound will often

give us. If the cause appears trivial, the statement of the fact, with a few cheering words, will reassure the wounded man, and soon restore him to himself. Where the depression is deeper and connected with a serious injury, the course pursued is to administer a dose of morphine in a drink of brandy and water. If conveniences are at hand, it would be advantageous to administer the toddy hot. The patient should be, at the same time, covered with several blankets or other warm clothing; pulverized mustard or red pepper may be rubbed upon the legs and arms, or plasters of the same substances extensively applied upon the skin, or the limbs may be encircled with bottles of hot water. The return of warmth to the surface, and with it an improvement in the strength of the pulse, is an indication that the heart will soon have force enough to drive blood to the brain and all parts of the body, to the relief of the patient and disappearance of the symptoms of shock.

As the wounded soldier is always clamorous of having his injuries attended to as early as possible, and as experience teaches that all wounds, and, above all others, gunshot wounds, are benefited by immediate dressing, they should be attended to on the field of battle. Under such circumstances, wounds give less trouble to the surgeon, less pain to the soldier, and much better final results in treatment. *All hasty dressings or examinations are to be deprecated, and a methodical course pursued.* The indications of treatment, in all gunshot wounds, are—1st. To control hemorrhage; 2d. To cleanse the wound by removing all foreign bodies; and, 3d. To apply such dressings, and pursue such a rational course of treatment, as will establish rapid cicatrization.

Hemorrhage, which produces such terror in the by-

standers and anxiety in the patient, should never unnerve the surgeon, who requires all of his self-possession and surgical tact to cope successfully with this ebbing away of life. Fortunately, in gunshot wounds serious hemorrhage is of rare occurrence; and when the largest arteries are injured, as a rule they either cease bleeding spontaneously, or the patient dies so rapidly that art is of little avail. In the Crimean war, researches into the cause of death upon the battle-field has given eighteen per cent. of the deaths to primary hemorrhage from the large blood-vessels of the trunk. If the case is not injuriously interfered with, the natural hæmostatics will often control the bleeding. In examining the table of ligation of arteries, it will be seen how very few cases are reported as having been operated upon for primary hemorrhage. In a consolidated table of all the ligations performed on the field, and reported by surgeons to the surgeon-general's office, during nearly three years of actual warfare, but two cases of primary ligation of the femoral artery and one of the brachial artery are noted. The ragged character of the wound, and the nervous shock accompanying the injury, or brought on by the loss of blood, reacting upon the circulatory organs, so diminish the heart's impulse that it drives little blood to the extremities, which favors a stagnation of blood in the wound. In those cases where the artery is completely severed, the formation of a clot plugs up the orifice in a bleeding vessel, and stops any further loss of blood. Where a large artery is but partially divided, the vessel can not contract and retract, thereby diminishing its canal, as is the case when the vessel is completely divided, and in such hemorrhage is much more frequently fatal.

This spontaneous arrest of hemorrhage is usually per-

manent; and, if the ordinary prophylactic course is pursued, of absolute rest and quiet, with the limb elevated, no return shows itself. Should, on the contrary, meddlesome surgery suggest the use of a tourniquet, which cuts off the circulation, and especially the venous return, the limb soon swells, tissues become engorged, excessive extravasation in the wound follows, and a train is laid for future mischief. The field tourniquet, in former days, was so much in vogue that it was considered indispensable on the battle-field, and was, therefore, carried in large numbers, so as to be applied to every limb from which blood was trickling, or from which hemorrhage was feared. Now they are nearly discarded from field service, and recent experience, based upon the carelessness with which they are used, recommends their abolition from the field, as doing more harm than good to the wounded. Unless very tightly applied, they are of no service, as they do not control the bleeding, and if firmly applied they act as a general ligature around the extremity, and can be used but for a short time without injury to the limb.

Recent writers warn surgeons of the too hasty use of hæmostatics, and suggest that it is better for the wounded to bleed, which will diminish the heart's propulsive force, than have the wounded tissues filled with extravasated blood.

The free admission of air to the wound has also a decided effect in hastening the clotting of blood, in stimulating the open mouths of divided vessels to contraction, and thereby in controlling bleeding. In fact, the free admission of air to a wound is classed among our best hæmostatics. Operating surgeons have frequently noticed that when flaps are brought together immediately after an operation, annoying hemorrhage

occurs within this sac, and, by its accumulation, stretches the sutures and makes tense the flaps. This distension becoming excessive, and threatening serious consequences, the sutures are divided, the flaps opened, and clots of blood removed, when the bleeding vessel will often so immediately close that it can not be found; nor will it again bleed. The same beneficial effects are found in gunshot wounds.

If the hemorrhage be free, immediately after the receipt of injury, the best mode of controlling it would be the application of a ball of lint, a compress, or sponge over the wound, secured by a bandage, which, in closing the outer orifice, favors the formation of a clot. If the hemorrhage is at all active, as from some large artery, in addition to the compress on the wound, the entire limb should be carefully enveloped in a bandage, to some distance above the injury, so that the pressure made upon the soft parts would diminish the amount of circulating fluid in the limb, and prevent the ingress of blood into the tissues. The hæmostatic properties of this dressing are very much increased by soaking the sponge, or compress covering the wound, with the perchloride or persulphate of iron, which, as a powerful astringent, when brought in contact with fresh blood, will immediately form a clot. Either of these preparations of iron poured into a wound, or the injection of a solution of the perchloride of iron into the wound, not using force enough to infiltrate the tissues, is an excellent method of establishing a solid clot up to the very bleeding mouth of the injured vessel. These preparations of iron are also used in the form of powder, and are equally efficacious. A lump of ice placed upon the compress will act with equal vigor. A sponge or compress, tied on the bleeding wound, with or without the iron styptic, is all that the

surgeon superintending the transportation of the wounded is expected to do.

Unless the hemorrhage is very violent, threatening immediate destruction of life, the tourniquet is rarely required. All recent writers on military surgery recommend that field tourniquets be dispensed with, as they are generally a useless, and often, when carelessly used, a dangerous instrument, and our extensive experience has not advanced their utility. They are still issued in large numbers, and called for by army surgeons only because they are upon the supply table for field service; but very few of them are ever removed from the medical store-chest, where they remain as mementos of a former practice. Surgeons of large experience on many bloody battle-fields have never seen it necessary to apply them. The finger pressure of an intelligent assistant is better than any tourniquet ever made, and is a far preferable means of controlling excessive hemorrhage, which the compress and bandage may fail to check. The femoral artery, for any injury to its trunk or large branches, should be compressed in the groin where it runs over the pubic bone; the brachial, where it pulsates against the head of the humerus, as at this point its course is nearly subcutaneous. When the position of these main trunks are shown to any intelligent assistant, and he is made to recognize the throbbing of the artery, he will have no difficulty in keeping the vessel compressed during the transportation. Should the surgeon be doubtful of the exact position of the vessel or the intelligence of his assistant, the finger may be thrust into the depths of the wound and be applied directly to the seat of injury in the vessel, thus temporarily checking, and if sufficiently long continued, often permanently controlling, the bleeding.

As soon as the wounded arrive at the temporary resting-place or field infirmary, where the surgeons are assembled, all bandages are removed, and the wounds carefully examined. A glance at the wound, when the clothing has been previously inspected, will often tell, when there are two orifices differing in appearance and in a direct line with each other, whether foreign bodies have lodged or not. As the patient is now faint from loss of blood and from nervous depression, the wound not yet being painful or swollen, the *surgeon, using his finger—which is the only admissible probe on such occasions that the military surgeon of experience recognizes*—examines with it, if possible, the entire extent of the wound, searching for foreign bodies. Where the orifice is too small to admit the index finger, the little finger will be found equally serviceable, and by flattening the limb, by making pressure upon the side opposite to and against the finger, a much greater extent of the wound can be explored.

This examination is made without fear of reproducing hemorrhage, as the finger can not displace the clots which hold firmly to the openings in the vessel. Every surgeon has noticed how rudely a stump might be sponged, and what force it requires to wipe away clots which have formed over the face of a smooth, incised, open wound. The adhesions are increased a hundred-fold by the irregularities of a concealed bullet track. The finger finds no difficulty in entering a hole through which a bullet has passed, if examined, as every wound ought to be, before swelling has taken place.

In examining fresh wounds, a silver probe will travel in the direction given to it by the surgeon; and *as most persons guide the probe instead of allowing the probe*

to guide them, the true course of a ball can only be determined by it with great difficulty. It is but recently that I saw a physician of experience, in seeking the course of a ball which had lodged in the thigh, pass the probe, apparently without effort, among the muscles quite across the limb, so that, the bullet wound being on the outer side of the thigh, the end of the probe could be felt under the skin on its inner side. When the finger was introduced, it followed the track of the ball at a very oblique course from the one which the probe had taken. This example, which is only one of the many of frequent occurrence, is sufficient to show why military surgeons of experience denounce the silver probe, and distinguish by its use the tyro in surgical practice.

In those cases only in which, from the small size of the orifice made by pistol balls, the finger can not be introduced, is a large bulbed ball probe, a female catheter, or, lastly, an ordinary silver probe, used. Elastic bougies have been recommended for the examination of extensive wounds, but they are apt to bend should they meet an obstacle or irregularity in the track, and when used for detecting foreign bodies do not convey the same satisfactory information as do metallic instruments.

The wound is examined from both sides, with the double object of finding foreign bodies which may have lodged, and seeing the proximity of the course of the ball to the main arteries of the limb. It is a matter of importance to determine the condition of large vessels, whether they be injured or not, by examining the degree of pulsation which they possess, as such an injury would necessitate a more careful after-treatment, in order to prevent secondary hemorrhage.

In some cases the finger introduced into the opening,

after passing through the skin and cellular tissue, finds no further passage. This sudden arrest of the finger would indicate either that the ball had been drawn out with the removal of the clothing, or that the deep tissues, muscles, and aponeuroses have changed their relations on account of changes in the position of the limb. The track of the ball will not be discovered until the former relations of the parts be resumed, by placing the limb in the same position in which it had received the injury, when the entire route of the ball will be traced.

The inexperienced, readily deceived by the little resistance met with in probing recent wounds, mistaking muscular interstices for the track of the ball, make several false passages in their search for the foreign body, and by their isolation or denudation of the parts cause inflammation and add to the difficulties of further examination. When the finger, buried in the wound, shows that it is continued beyond reach, a ball probe or silver catheter, introduced *carefully and without force*, will often reach and detect the foreign body.

In the examination of gunshot wounds, to detect the presence of a ball, when, by the use of a silver ball probe, a hard foreign body is discovered, but from the depth of the wound and the little play of the bulb of the probe, it is impossible to determine whether we are feeling an exposed portion of bone or cartilage, or have actually found the foreign body which we are seeking, we can at once solve our doubts and establish an accurate diagnosis by means of Nelaton's probe, which differs from the ordinary ball probe in having an unglazed porcelain bulb at its extremity. When this bulb, buried in the depth of a gunshot wound, reaches the suspected foreign body, it is only necessary to rotate it a few times against the hard

mass and then withdraw it; when, if it has been rubbed against a lead ball, its surface will be blacked by particles of the metal, which discoloration can be produced by no other substance. This simple instrument is a triumph of surgical ingenuity.

Should but one opening exist, and the clothing of the soldier covering the wound be torn, the probability is that foreign bodies complicate the wound. When two openings exist, indicating the escape of a ball, an examination should still be made, to detect, if possible, the presence of foreign bodies, such as portions of clothing, etc. It must be remembered that the ball, as a hard body, can usually be readily recognized, but that portions of wadding or clothing may be easily mistaken for a clot of blood or the ragged lining of the wound. This is particularly the case when they become saturated with the secretions. Forewarned being forearmed, the surgeon, remembering these difficulties, will examine with special care for these soft, foreign complications. When found they should be extracted, as their presence is certain to establish a high degree of inflammatory excitement, with profuse and long continued suppuration.

This effect was well shown in the case of a private of the Second regiment of South Carolina volunteers, who, during the attack on Fort Sumter, was shot by the accidental discharge of a musket. The ball entered the chest at the anterior fold of the armpit, fractured the clavicle, and, after a course of nearly six inches, was stopped by the tough skin over the posterior portion of the shoulder. The ball was readily detected by the regimental surgeon, and, by an incision through the skin, was easily removed. Inflammation of a high grade having supervened upon the accident, he was sent to the general hospital one week after the

injury was received—at which time he was losing from three to four ounces of pus daily. On the day after his admission, in examining the wound, I detected in the shoulder wound some substance resembling a slough, and, upon extracting it, found a mass of coat pad, over two inches long and as thick as the finger, which tent-like mass had been driven into the wound, and having been entangled by the irregular tissues through which it had been driven, had been left behind by the ball. An examination of his clothing, made for the first time, showed a deficiency in the lining of his coat, from which this mass had been torn. The removal of this irritant diminished the discharge immediately, so that, in the succeeding twenty-four hours, the discharge diminished to one-sixth its former quantity, and in four days was hardly sufficient to soil the dressing.

The history of the case is of much importance in examining gunshot wounds, as often the course of the ball can not be discovered without it. What surgeon, however great his experience, seeing a wound made in the arm by a ball, would think of looking in the opposite thigh for its place of lȯdgement, did he not learn that the injury was received from above, while mounting a scaling-ladder, with arms raised above the patient's head? The ball entering the back of the arm near the elbow, had passed down the arm under the shoulder-blade, across the loin, and, traversing the buttock, had lodged under the skin of the outer part of the opposite thigh, where it was found and removed.

A case in point was that of Private R., 7th S. C. V. regiment, who was shot in the neck at the Battle of Malvern Hill, June 30, 1862. His wound was considered trivial, and a furlough of thirty days granted. He came under my observation a few days after the re-

ception of the injury with the neck very much swollen, and a severe pharyngitis, with tonsilar enlargement seriously obstructing respiration and deglutition. The swelling on the back of the neck caused him to carry the chin touching the sternum. A large orifice, from apparently a minie ball, existed on the left side of the neck, one and a half inches from, and on a level with, the spine of the sixth cervical vertebræ. When the wound was probed it was found to traverse the neck, running over without fracturing the spine of the cervical vertebræ, and then to change its course obliquely downward and outward. Profuse suppuration soon came on, the pus burrowing under the right scapula, caused, as was supposed, by some foreign body, probably the ball, as there was but one orifice to the wound. After some days of treatment an opening was made on the right side of the back, above the upper edge of the scapula, and the neighborhood thoroughly explored. The subscapular region was found undermined and the neck of the scapula fractured, but no foreign body could be discovered after the most careful search. Suppuration continued profuse for weeks, reducing the patient to the very last extremity, with extreme emaciation. He finally rallied, thanks to a good constitution and good nursing, and was at last sent home convalescent. In time an abscess formed in the immediate vicinity of the elbow joint, and a large minie ball was extracted from this situation. When he received his wound he was loading his rifle, and was in the act of biting the cartridge, with arm raised and face depressed. With this history of the case, the position of the ball could be readily accounted for.

Knowing the direction from whence the ball came, and the position in which the soldier was placed, you

will suspect the course which the ball would most probably take; and your examinations in that direction will not only save much time, but save the patient much suffering and annoyance.

The probing of wounds to find incarcerated balls should be accompanied by a thorough and extensive external examination of the surface, by running the hand over the limb or trunk, pressing both lightly and firmly, in order to detect any abnormal induration. The position of balls is often discovered by palpation alone, and in certain cases large masses of iron have remained embedded in the soft parts unsuspected. McLeod recorded a case from the Scutari hospitals, in which a piece of shell, weighing three pounds, had buried itself in a soldier's leg, making so small an opening that its presence was overlooked for three months. Larrey reports a case in which a five-pound ball buried itself in the thigh; Begin a case of a nine-pound ball; and Hennen one in which a twelve-pound shot remained in the thigh, and was only discovered after death. As round shot are rarely used in modern warfare, no such case has yet been reported from our armies. For this examination the entire limb must be exposed, and, in injuries of the trunk, the patient should be stripped. Valuable assistance is often obtained from the patient himself, who suggests, from increased sensitiveness over a particular point, where the ball might be found, or he may have detected the ball by the sudden formation of a tumor where no hard swelling had before existed.

Often the play of a muscle will shut off the track of the ball. The relations of the soft parts vary with every position of the limb, and a passage made when a limb was flexed could not be followed when the same limb is extended. Hence the necessity of plac-

ing the limb in the same position in which it was when the injury was received.

The wound having been carefully examined by the finger within and careful manipulations without, and the foreign body detected, it should be at once removed. This rule may nearly be considered absolute, as all military surgeons place great weight upon its accomplishment. The question is not so much whether balls *can* remain innocuous in the flesh, *but do they?* Those who have had experience in the treatment of gunshot wounds know how excessive is the irritability caused by the presence of a ball in a wound; how restless and irritable the patient is until it is removed; how profuse the suppuration and prolonged the period of treatment in those cases in which it has been left; and how frequently the after-consequences are so distressing, the pain so permanent, and discharge so constant, as to demand future interference, or make life a burden. If such be the case with a ball, how much more urgently is the extraction of other foreign bodies indicated, especially fragments of shell, portions of clothing, detached pieces of bone, etc.? It is only by carrying out this most urgent indication in the commencement of the treatment that a number of consecutive dangers, such as pain, inflammation, suppuration, gangrene, amputations, and even death, can be avoided.

Balls may, in time, become encysted; but even when such occurs their presence, in after years, may set up inflammation, which will mat together and bind down important parts, whose usefulness depends upon freedom of motion. Repeated abscesses may form, pressure upon bones may give rise to ulceration and a tedious exfoliation, blood-vessels may ulcerate, nerves be painfully compressed, and life rendered miserable,

if not jeoparded. Notwithstanding all that has been written upon the innocuous character of balls embedded in the flesh, for every instance in which they have thus remained, without giving trouble, one hundred can be exhibited showing the great danger of foreign bodies in the living tissues. Baron Larrey's experience showed that, as a rule, amputations are eventually necessary, after years of suffering, in those cases in which balls have been left embedded in bones. These remarks are equally applicable to all foreign bodies, including spiculæ of bone.

In McLeod's Surgery of the Crimea, the report of M. Hutin, chief surgeon of the Hotel des Invalides, is given, which is a striking commentary in favor of the removal of all foreign bodies. He reports that, of four thousand cases examined by him, in which balls had remained embedded, only twelve men suffered no inconvenience; and the wounds of two hundred continued to open and close until the foreign body was extracted.

The experience of the various hospital boards throughout the Confederacy for the examination of wounded soldiers on furlough, will attest the importance of M. Hutin's remarks. Very rarely is a soldier found returning to his regiment with a ball unextracted, and in those cases in which the position of the foreign body escapes the careful examination of the surgical staff, painful and often contracted limbs are uniformly met with, rendering the patient totally unfit for service.

When no doubt exists that a foreign body complicates the wound, the surgeon should neglect no precaution to discover it. As a general rule, he will find the examination facilitated by exposing the entire limb.

If the ball be felt loose in the soft parts, a bullet forceps can be made to seize it; and it can be extracted without difficulty, *provided the disengaged hand of the surgeon support the limb on the opposite side to that at which the forceps is introduced;* otherwise, the ball glides in front of the forceps and can not be seized. The ordinary bullet forceps, simulating the dressing forceps of the pocket-case, was the instrument preferred by Larrey, and is still in general use. Many changes have been made in these, without advancing, to any extent, the merits of the instrument. An excellent bullet forceps, which is the one now issued in the Confederate service, terminates with a sharp prong on either blade, at right angles to the blade, so that, when closed, the points are protected by the blades. These act as an axis upon which the ball may be rolled out of the wound, instead of being drawn out, as with the dressing forceps.

In my own experience, I have found an ordinary dissecting forceps, with toothed extremity, such as is met with in all recent pocket-cases, the most convenient instrument for extracting balls. The teeth, embedding themselves in the lead, allow of firm traction without fear of the instrument slipping, which is so constantly the case when the common bullet forceps is used. In removing a flattened ball, especially a mashed minie ball, a good deal of force is often required to disengage and extract the irregular mass from its bed in the soft parts. The long, ordinary bullet forceps is an unnecessarily clumsy instrument, made apparently with the belief that the ball will, in every instance, be sought for through a long track of several inches, while rarely is this the case. The ball is usually found near the surface, and can be readily removed by a short toothed forceps, which is much more conveniently handled.

Should the site of the foreign body be not at once evident after the examination of the wound, the limb should be carefully manipulated for some distance from the wound. As the object of the examination is to detect abnormal projections, the slightest elevation should attract attention. When no projection is visible, palpation may detect a hard body at a great depth in the tissues. The hand should, at first, be run lightly over the surface, as light pressure would expose the indurated spot, the site of a ball, when well defined pressure would move the object, push the ball back into its track, and cause its disappearance. If the tissues are soft, the foreign body can be seized between the fingers. If this be impossible, palpation over the region, as for detecting fluctuation, will discover the hard, resisting, circumscribed body. Experience soon makes perfect in this kind of research, and mistakes are rarely made.

In cases of long standing, when in doubt whether an induration be a ball or a persistent deposit from previously existing inflammation, an enlarged lymphatic gland, or a cartilaginous formation from an injured and excited periosteum, I have found valuable aid to diagnosis from the use of a fine cutting needle, such as is used in couching or breaking up the lens in cases of cataract. This very small sharp instrument can be used upon any portion of the body, leaving no mark. It gives little or no pain in transfixing the tissues, and the sensation imparted by the point of the needle embedding itself in lead is so peculiar that a surgeon, with experience in its use, can not be mistaken in the diagnosis of an induration where the presence of a ball is suspected. Should a ball have traversed a limb, as it often does, and its escape be resisted by the tough, elastic skin which very often successfully inpedes the further progress of the ball, it should be removed by

making an incision over its position, and not be sought for, and drawn through, the entire length of the track which it had traversed.

In removing subcutaneous foreign bodies, do not cut down directly upon them, as it will destroy the edge of the knife—a sad accident in field practice, where no conveniences exist for putting instruments in order. Steady the skin over the supposed site by fixing the prominence *in situ* between the thumb and index finger of the left hand. A sharp-pointed straight bistoury held obliquely, the edge turned toward the operator, is then thrust obliquely through the skin and cellular tissue until it strikes the foreign body, when the handle of the knife should be brought over toward the operator, thus describing a segment of a circle, and making a sufficient opening in the skin to allow of the ready escape of the ball.

If the ball is located in the vicinity of important blood-vessels or nerves, and there is fear of injuring important structures by a bold thrust, then the incision for its extraction must be made with more care by a gradual dissection from without, dividing the tissues layer by layer.

When a ball is firmly embedded in bone, it can be removed by boring into it with a gimlet, which holds it securely, and permits sufficient force being used for dislodging it, or it may be cut out by using a trephine or gouge. The latter instrument I have found particularly useful in opening a passage through bone, so as to permit the ready removal of an impacted ball.

After exposing a point of the foreign body, make the incision to one side, or pass in a grooved director and cut outward, when there will be no fear of doing harm to the cutting edge of the knife.

Baudens, in noting the difficulty of extracting these

subcutaneous balls, ascribes it to a layer of cellular tissue which has been driven in front of the ball, and which firmly and completely caps it. It is thin enough to be nearly diaphanous, and yet tough enough to clasp and hold firmly the bullet. This condensed cellular tissue must be completely divided. My own experience corroborates that of Guthrie, who says that the difficulties of extraction are increased by the surgeon when fearful of making a free incision. *Balls can be extracted with the least pain and with great rapidity by making a bold incision.* This course marks the difference between civil and military surgeons; half an inch added to the incision does not increase its dangers, and expedites materially the extraction. Be quite sure, however, that you are cutting upon a ball and not upon some bony prominence, which comparison with the opposite limb should warn you from. It is sufficient to mention that such mistakes have happened to military surgeons.

By foreign bodies we mean balls, pieces of clothing, spiculæ of bone which have been broken off and are loose in the wound, and any articles about the person which may have been driven before the ball. These should all be removed immediately after the injury has been received, and before swelling or infiltration renders the task difficult. When done early, the wound will be found sufficiently large to allow of easy extraction without dilating. It is only when this early attention is neglected, and the wound has closed by inflammatory effusions, that the removal is painful and difficult, requiring, in some instances, the use of the knife to enlarge the passage. When a ball alone complicates a wound, if it be not readily found after a careful and intelligent search, rather than continue the examination from day to day, which can only be

prejudicial to the case from the irritation and inflammation which will be excited, it would save the surgeon much anxiety and the patient much annoyance if the ball or other foreign body be left until suppuration be well established. Then it will gradually expose its situation, and can be much more readily removed than during the height of reaction, when the parts are very much swollen and very painful. The surgeon will assist nature in the expulsion as soon as the swelling has subsided to such an extent that the finger or the forceps can again be introduced into the wound.

The dilation of gunshot wounds, which was formerly the constant rule of practice, is now altogether rejected from military surgery, unless it be for the special purpose of ligating a bleeding artery, or extracting foreign bodies, including spiculæ, which could not be otherwise readily removed without injury to the soft parts. This old medical dogma was based neither upon experience nor observation, and is now very properly considered useless, injurious, and barbarous.

It often happens that, after repeated examinations, the site of the ball can not be fixed, although we may feel assured that it still remains embedded somewhere in the tissues. Unless serious symptoms exist, as severe and constant pain indicating pressure upon an important nerve and leading us to suspect its position, we are not justified in cutting down at random to look for a ball. Unless we can locate with some certainty the foreign body, it is a good rule not to attempt its search. *Tentative incisions usually fail of their object, and should not be made.* There is no excuse for groping about blindly, hoping to stumble upon a ball which is hid away in the tissues. Unless we can feel the ball, we must have very strong reasons for believing it located in any particular situation before resort is made

to the knife. Having found a ball, it is equally our duty to remove it, however important the parts among which it is located—as its presence, if left in the living tissues, always entails more serious trouble than the dangers arising from the operation required for its removal. At times such operations require all the skill of adepts in surgery to accomplish safely the object; but this does not affect the established rule: *when a ball can not be located, never operate for its removal unless forced by the presence of serious symptoms, which may threaten the life of the patient. Where a ball has, on the contrary, been found, always extract it.*

The above rules apply chiefly to gunshot wounds of the extremities; those of the trunk and head offer so many exceptions to the above, and require, in a measure, such special treatment, that the course to be pursued in such wounds, complicated with foreign bodies, will be specially dealt with in discussing special injuries.

We have already stated that fatal hemorrhage, from the large vessels of the extremities, does not often occur on the battle-field; and that when such arteries are wounded, the hemorrhage is either so immediately fatal that no assistance can be rendered, or it ceases spontaneously. The nervous depression so common to serious gunshot wounds, with its tendency to syncope, and its control over the circulatory organs, checks the impulse and supply of blood through the injured vessel, and promotes the formation of clots. Instances are reported in which openings in arteries have been temporarily closed by foreign bodies, and in such cases hemorrhage had recurred when these had been extracted. Cases are often met with in which the largest arteries had been wounded, and in which bleeding ceased spontaneously.

When hemorrhage is not actually going on, or the amount of blood lost has not been seen, the only means of detecting the injury of the large arteries of a limb would be in examining carefully the strength of pulsation in the vessel beyond the point of injury. A diminution of its force when compared to that of the corresponding vessel in the opposite limb, and especially an absence of pulsation, shows conclusively some hindrance to the circulation. The presence of the pulse is, of course, no indication that injury has not been received.

Although from the course of the ball and the flow of blood we know that the main vessel of the limb has been injured, if the bleeding has ceased spontaneously, or by the pressure of the sponge or compress which was tied over the wound, the artery should not be interfered with. *In by far the majority of cases, if proper precautions be taken, there will be no recurrence of the hemorrhage.* The patient should be kept perfectly quiet, free from all causes of excitement, at perfect rest, and, to ensure that the limb shall not be moved, a bandage should be carefully applied from the extremity of the limb upward, and a long splint secured. The flannel bandage being the most elastic, is the best material for such methodical pressure and support. Elevation of the limb will add much to the efficacy of the preventive treatment. The accumulated experience of field surgeons through all the campaigns of this revolution, and their condensed reports of surgery on the battle-field, will show how rarely is it necessary to ligate large vessels injured by the passage of balls, and how successfully nature controls permanently the hemorrhage from large arteries.

The *ligation of an artery*, which is the only sure precaution against the return of hemorrhage, is not only

a difficult operation, requiring much skill for its successful performance, but when necessary to control the bleeding from a recent wound, becomes a very dangerous one to the safety of the limb or life of the individual. In cases of disease, nature, always on the alert, has enlarged contiguous blood-vessels, which are ready to assume all the functions of the one requiring obliteration. In a wound in a healthy person no such preparation has been made; and in cutting off the main supply of blood through a limb, it becomes a very serious question, often answered by the loss of the limb, and even life, whether the circulation will be re-established in time to save the member from mortifying. When a ligature is placed upon the main artery of a limb for disease, previous developments in the collateral circulation have been made to such an extent that the extremity may not even lose temperature after the ligation, and as there is no diminution of the nutrient supply there is no fear of mortification. If placed on a healthy vessel for an injury, the limb at once becomes pale and cold, requiring the application of artificial warmth and enveloping in flannels to support life in it until the circulation be re-established, when the limb becomes actually warmer than its colleague, because the supply of arterial blood is now disseminated in vessels much nearer to the surface, while before its chief channel was deeply embedded in the tissues.

The rapidity of this collateral development in the limb is well exhibited in primary and secondary amputations. When a thigh is amputated in a healthy portion, very seldom are there more than three or four ligatures required to stop all oozing and render the stump quite dry. If the amputation be necessary at the same point four or five days after an injury to the

main vessel has been received, the number is greatly increased; as many as twenty-eight arteries having been ligated by Langenbeck after amputating a thigh under similar circumstances.

Should active hemorrhage continue, and show no disposition to cease, or the quantity of blood flowing from the wound indicate speedy death unless the hemorrhage be stopped, the wound should be dilated, the bleeding mouths of the artery found, and *a ligature applied both above and below the injury.* This has become the established practice, and the only safe one, taking its place among the aphorisms of surgery. The universal adoption of this practice is not only based upon experience and observation, but could be determined *à priori* from the physiology and anatomical distribution of arteries.

All surgeons are familiar with the anastomosis or collateral circulation in blood-vessels. When the current of blood, flowing through a main vessel, is stopped at any one point, it will soon find its way, by retracing its steps through many circuitous routes, until it comes in from below, and thus back to the very point at which its direct course had been checked. When an artery is divided, it it well known that, owing to its muscular and elastic structure, that portion above the wound at once contracts and retracts, so that the tube, which was before cylindrical, now resembles, in form, a claret bottle with a much constricted neck at the point wounded. A clot of blood soon forms in this mouth and neck, and the further escape of blood through this opening is intercepted. In the lower portion of the divided vessel similar changes are going on, but not to so great an extent. The contraction (owing to the severing of the nerves which run upon and between the coats of the vessel, and which give

tone to the arterial walls) is only partial, the walls being to a certain extent paralyzed, and so little blood remains in the tube that a very small and indifferent clot is formed.

When the upper portion of the artery is firmly closed, preventing all egress to blood, the lower portion remains patulous, inviting hemorrhage. As soon as the blood-currents find their way by circuitous channels to the lower portion of the injured vessel, it wells up from the wound in a continuous purplish stream, all impulse having been lost, and also most of the oxygen contained in the blood, by the long, roundabout way which the circulation now takes. The darkness of the blood will depend upon the difficulties of the circuitous passage; the rule, however, is: scarlet or arterial blood from the upper end of the vessel, blood more or less dark colored or venous from its lower end. It must be remembered, however, from what has been just said, that the color of the blood in secondary hemorrhage is no criterion of the kind of vessel from which it flows.

Guthrie lays down the two following rules as the great principles of surgery, to be observed in the cases of wounded arteries, and which ought never to be absent from the mind of the surgeon:

1. *That no operation ought to be performed upon a wounded artery unless it bleeds.*

2. *That no operation is to be performed for a wounded artery, in the first instance, but at the spot injured, unless such operation not only appears to be, but really is, impracticable.*

These two aphorisms are the more particularly applicable to recent wounds of arteries, as we will have occasion to mention exceptions to both of these rules when discussing the modified conditions of the wound

and wounded in reference to cases of secondary hemorrhage.

When it is necessary to ligate an artery, the surgeon must be guided, in finding it, by his anatomical knowledge, and also by the pulsation. In dilating the wound so as to expose the bleeding mouths, the incisions should be made parallel to the course of the vessel, and sufficiently free to facilitate the search. The dissection is carefully conducted, dividing layer by layer, and avoiding the nerves and veins which always accompany the large arteries. When the bleeding mouth is so exposed that the origin of the jet of blood is seen, the vessel is transfixed by a tenaculum, drawn out, and secured as it would be in a stump after amputation.

Where it is impossible to ligate the bleeding vessel at the point wounded, a point should be selected, at which the vessel is comparatively isolated, easily discovered, and free from large collateral branches. *In exposing it, make a free incision.* The common error that most surgeons commit is in making a small incision, which hampers the search. When we approach the artery, use the grooved director to isolate those cellular layers in which the vessel is always found. The point of the knife should *never* be used for this purpose. The lips of the wound should be drawn asunder by an assistant, so as to give to the operator the light necessary for accomplishing, speedily and successfully, the ligation. In all cases requiring such an operation, it is desirable to have the patient completely under control, and, therefore, chloroform should be administered.

When the artery is found and the ligature passed under it, before tying it be quite sure that it is the vessel, and it alone, and not the nerve, that has been

seized. To be satisfied on this point it is only necessary to draw slightly upon the thread, and examine above and below it to see whether the pulsation has altogether ceased below the ligature. Having determined that the thread is properly placed, it is then firmly tied. The ends are brought out of the wound and secured under a strip of adhesive plaster, attached to the immediate neighborhood of the wound. This mode of disposing of the ligature will protect it from becoming entangled in the ordinary dressing, and from being drawn upon when these are daily removed. Water dressings form the proper after-treatment. The thread will come away spontaneously, by the eighth, twelfth, or sixteenth day, according to the size of the vessel ligated.

Local Treatment of Wounds.—Having removed all foreign bodies, and hemorrhage having ceased, the dressing now required should be of the simplest description. It is known that gunshot wounds, belonging to the contused variety, show a constant disposition to suppurate, and often to slough. *This process of suppuration is not necessary to the healing of the wound, and should be kept in subjection as much as possible.* This is effected by the continued application of cold water, which, by keeping down excessive reaction, and keeping out an excess of blood, diminishes the source of the purulent supply, and thus hastens the cure. In former times, suppuration was considered essential in the healing of all wounds, by permitting the escape of so much poisonous matter, which had accumulated in the system, and which must either now find a vent, or, if retained, would be considered the satisfactory cause of any sickness from which the wounded man may hereafter suffer. The wound was, therefore, under this

exploded belief, plugged with a tent, piles of greasy lint in cushions were applied, and, after covering with a sufficient number of compresses and bandages, a forcing bed was formed, which supplied pus to the satisfaction of all interested. It was common enough, under such treatment, to see life drain away from this opening.

This smothering of wounds in hot poultices, and the smearing on of greasy ointments, which the wounded formerly encountered, was a second enemy, far more fatal than the enemy on the battle-field—as in its ranks were found exhausting suppuration, with its hectic; pyæmia, with its rapid poisoning; hospital gangrene, with its fatal collapse, and erysipelas, with its thousands of victims; broken-down constitutions, tedious convalescence, and very protracted cures, with endless pains and annoyances.

How much more rational is the present practice! *Keep away all hot dressings, which invite blood to the part.* Vote poultices and greasy pledgets a curse, and eject the dirty, troublesome applications. Guthrie says poultices should not be permitted in a military hospital; they are generally cloaks for negligence, and sure precursors of amputation in all serious injuries. With more recent writers they even meet with less favor, and the very extensive experience of the Confederate hospitals confirms this opinion.

The only dressing required for wounds, of whatever character, is the water dressing, and it should be used as follows: apply a single thickness of wet linen or cotton cloth over the wound, allowing it to extend over a considerable surface. If possible, cover this with a layer of oiled silk, waxed cloth, or india-rubber tissue. A second layer of cloth or a band secures the two former layers in position, so that they will not be displaced by

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the movements of the patient in sleeping. Then either squeeze cold water frequently upon this outer cloth, which will keep up the low temperature; or adopt the much more convenient and less laborious plan of suspending a bucket, or some vessel containing water, in the neighborhood of the wound, having a narrow slip of cloth, or, what is better, a lamp wick passing through a hole in the bottom of the suspended vessel to the bandage upon the wounded limb. By capillary attraction, a constant stream of water is carried from the vessel to the dressing, and, by its evaporation—robbing the skin of its animal temperature to get a sufficient quantity of heat to convert the water into aqueous vapor—refrigerates the limb. The wick must run freely through the hole, but not too loosely, or the water will flow out too rapidly. If it passes through snugly, so as to block up the orifice, capillary action will not draw off the water, and the parts will not be irrigated. The advantage of using oiled silk, waxed cloth, or india-rubber tissue is, that should the supply of water accidentally give out in the suspended vessel, as it frequently would do, from inattention of nurses, the piece of cloth beneath it remains moist upon the wound. The wet cloth absorbs the discharges, and should be changed two or three times a day, it being well understood that they be disturbed as seldom as possible, compatible with cleanliness.

At a very recent meeting of the society of army surgeons, held at Richmond, the subject for discussion being the use of cold water dressings in the treatment of gunshot wounds, with but very few dissenting voices, unanimous assent was given to the judicious use of cold water as the only proper local application for wounds. The past two years in the Confederate hospitals have given more extensive opportunities for

testing the advantages of water dressings than had ever previously been offered since the introduction of this method as a remedial agent. The wounded who have been brought under its happy influences can be numbered by tens of thousands, and the magic effects of this dressing, when judiciously used, and the consequent high esteem in which it is deservedly held by all army surgeons, has established, above all cavil, its superiority over all other dressings.

Like all good remedies, it is capable of much abuse, and yet it is so simple, and even when misused, doing comparatively but little mischief, that its application has been put into the hands of every wounded patient. In applying it judiciously, it is not necessary to have the patient swimming in water. When the wound exists upon the limbs, the bed can be so arranged that the water as it is conveyed to the wounded will, when it has refreshed the patient by its cool temperature, run off into some receptacle, without spreading over the bed and wetting all the clothing of the patient. A piece of oiled or india-rubber cloth is usually placed under the wounded limb to protect the clothing of the bed and patient. When the wound is seated upon the trunk, it would be dangerous as well as very annoying to the patient to have a stream of water running over his person; therefore cloths, rinsed frequently in cold water, to be changed as often as they become warm, takes the place of irrigation, and is the proper method of applying cold water dressings. Cold water applications are advantageously applied to wounds immediately after they have been received, and are only contraindicated by existing shock. As long as marked nervous depression is present, cold applications would tend to increase this serious complication; nor are there any indications for its use under these

circumstances, as there would be neither hemorrhage to be checked, pain to be soothed, nor nervous irritation and vascular excitement to be controlled. It is only when reaction is being established that the advantages of cold applications become apparent. In cases where nervous shock does not accompany the injury, cold water can not be applied at too early a period to wounds.

The surgeon should never be in haste to change the cold for warm applications. Should, however, in the course of treatment, the virtues of a poultice be called into requisition, a soft, wet compress, covered with oiled silk or india-rubber tissue, and secured by a flannel roller or outer compress, will be found to combine, in a simple form, all the properties of a poultice. It is light, moist, soft, and is kept warm by absorbing animal heat, which the oiled silk and outer compress retain. If we add to these properties cleanliness, facility of medication, and the readiness with which an impromptu dressing can be made, we find an array of advantages which exclude all substitutes.

A more effectual mode of keeping down reaction is, by using ice bladders, which are placed upon the india-rubber, waxed, or oiled silk covering. These are of very general application, and make the least call upon the personal attention of nurses. *Whenever ice is used, never apply it directly to the skin, but always through the intervention of compresses*, which may be made sufficiently thick to accommodate the application to the sensitiveness of the patient. When possible, these bladders should be of india-rubber or gutta-percha, as such materials are impermeable to water and permit of water applications for the reduction of temperature, at the same time keeping the body and bedclothing dry—a very great desideratum. A large supply of

these should always be on hand. The animal bladder is a miserable substitute, as it is not only a very dirty application, allowing the water to ooze out and keep the patient constantly wet, but the bladders soften and decompose. becoming very offensive, and are soon destroyed.

Cold water is the only proper and universal antiphlogistic that can be applied to wounds. It has the convenience of always being at hand, it keeps up a uniform action, is clean, simple, cheap, agreeable to the feelings of the patient, easily obtained, easily applied, demands least care from the nurses, who have their hands usually full, and is withal effectual. *With the judicious application of cold water the surgeon can defy inflammation.* Cold acts by keeping down temperature and constringing vessels, thereby keeping blood from the part injured; so that inflammation, which consists in the engorgement of blood-vessels and an excessive supply of blood, can not get a foothold. Heat, redness, pain, and swelling, all depend upon congestion; control the supply of blood to a part, and inflammation is kept in abeyance. It also acts directly upon the nervous element of the tissues, by its local sedative effect, blunting sensibility, allaying pain, removing irritation, and thereby the excitement in the circulation.

As the advantages of cold water dressings are obtained through the evaporating properties of water, this action may be increased by medicating it with saline substances or alcoholic tinctures. Sugar of lead, sulphate of zinc, tannin, muriate of ammonia, laudanum, spirits of camphor, and especially tincture of arnica, would be useful adjuvants. Some surgeons consider any addition as detrimental to the efficacy of simple water; but, unfortunately, simplicity is but little in accordance with the popular taste.

While the irrigation is going on, the compresses next the skin may be moistened every three or four hours with any of the above preparations. There are a few persons to whom the application of cold water is inadmissible. In every case the feelings of the patient will be our guide as to the applicability of the remedy. When not grateful and refreshing to the patient, but, on the contrary, the cause of complaints, with tendencies to chilliness, the irrigation must be superseded by a wet compress, covered with oiled silk or a waxed cloth. This will soon attain the temperature of the body, and will keep the parts moist and soft. The dressing requires to be changed three or four times in twenty-four hours; not that the compress would get dry, for the perspiration from the part, and discharges from the wound, which are kept in by the oiled silk, would bathe it in a continual and permanent moisture. The object in renewing the wet cloths is to get rid of these secretions, which, in decomposing, would irritate the wound.

A question of great moment is, when should we desist from water applications, and change for some more useful or appropriate dressing? According to the present rational views of surgeons, no other dressing is ever required, however serious the wound may be. As long as inflammation threatens, so long is it necessary to prevent engorgements. As long as suppuration is kept up, so long will the efficacy of cold be required to constringe the blood-vessels and control the source of the purulent supply.

Pus, which we call a healthy fluid, is a heavy drain upon the system. It is made from the richest ingredients of the blood, which were intended for the repair of tissues. Once converted into pus, it is unfit for any further useful purpose, and is, therefore, a waste of

precious material. This discharge is not more necessary to the healing of wounds than to the nutrition of the body. Extensive wounds, healing by the first intention, do very well without its intervention. Large subcutaneous wounds, when even their sides are not kept in apposition, heal with rapidity without the formation of pus. Under a scab we find tissues form, by what has been called the remodelling process, without it; and it should be our constant effort to heal all wounds, and I would say, especially gunshot wounds, with the least possible discharge. Hence the water dressing can be continued beneficially for weeks, or as long as the wound remains unhealed. Our experience in the treatment of gunshot wounds, which accords with that of most army surgeons, is that the wet cloth should be kept on until cicatrization is completed; and that no other application so protects and promotes the formation of new skin.

I would, however, call attention to a general cause of annoyance in the use of water dressing. The main object of the cold water application is to prevent or control inflammatory action in the wound and its vicinity. Whenever all the symptoms of inflammatory excitement, viz: heat, redness, pain, and swelling—have subsided, leaving a wound which suppurates but little in a limb of normal size and appearance, the application of cold water, by irrigation, has fulfilled its duty, and is no longer beneficial. If the entire surface of the limb should now be kept enveloped in wet cloths the skin becomes irritable, the sebacious follicles take on suppurative inflammation, and crops of very annoying boils, accompanied by interminable itching, succeed each other with persistent regularity, until the dressing is changed. When the symptoms of inflammatory excitement have disappeared from

the wound, which in simple gunshot wounds is usually about the tenth day, instead of continuing the water dressing over a large surface of the limb, confine its application to a small compress over and immediately around the wound; cover this with a piece of oiled silk, only a little larger than the compress, and secure both in position by a bandage—the wet cloth to be renewed two or three times a day. The oiled silk keeps the cloth moist, preventing the secretions from drying and forming a hard, painful crust over the wound, which, by retaining the secretions, would become the cause of pain. By retaining the moisture it also prevents the cloth from adhering to the edges of the wound, and thereby not only saves the patient much pain at the renewal of the dressings, but avoids the injury to the granulations. This is recognized, after the removal of dressings carelessly applied, by the bleeding from the surface, and more particularly the edges of the wound, where the new, delicate skin is forming, and which, if rudely torn day after day by cloths adhering to the wound, will cause it to take on an irritable or indolent condition which is averse to healing.

There are a long list of ointments which have heretofore held universal sway in the treatment of wounds, among which simple cerate is the most conspicuous. Although this is a simple and innocent preparation, as its name indicates, and is extensively used in the army as an application to chronic wounds, even this can be dispensed with for the more simple water dressing. Should the wound require stimulation, the nitrate of silver wash, grs. xx to the ounce, when brushed over the part, will suffice; or tincture of iodine, or iron, or some stimulating astringent, might be equally applied in addition to the water dressing,

so that any imaginary condition of the wound might be successfully met by the medicated wet cloth.

The disturbing influences in the healing process of wounds are numerous, and most of them are capable of correction without much trouble. Among these are found imperfect transportation over rough roads in improper vehicles; bad attendance, including rough or too frequent examinations; useless and excessive bandaging, which promotes infiltration; too frequent dressing; improper food; scorbutic, syphilitic, and other diseases; the moral depression of defeat; and, above all, imperfect ventilation and insufficient regard to cleanliness, and over-crowding in the wards of military hospitals.

We have already said that a surgeon is never warranted in cutting down upon an artery and tying it upon suspicion; he must be an eye-witness of the hemorrhage, and see that it can not be controlled by other means. The ligation of an artery is always a troublesome operation, and, from the fear of subsequent mortification, always jeopards the limb, and necessarily with it the life of the patient. This is especially the case in recent wounds, before nature has prepared a collateral circulation; so that the rule which we have laid down is imperative, as far as it relates to recent wounds—*never ligate an artery, however large, in which hemorrhage has spontaneously ceased.* Moreover, a good compress is usually sufficient, when applied immediately after the receipt of injury on the battle-field, to stop the bleeding even from the largest vessel; and position, quiet, rest, and other prophylactics, will most frequently prevent its return.

It has often happened that, after an injury had been inflicted upon an artery of large size, the rapid flow of blood from the wound had brought on syncope, which

was more or less prolonged, followed by nervous shock and a depressed condition of the nervous system of considerable duration. It is under such influences, controlling all activity in the circulation, that the bleeding ceases spontaneously and clots of blood form. Should a person suffering from such an injury be not disturbed by rough transportation, nor be too freely stimulated, the blood forms firm clots, which may close up the orifices in the injured vessel, and become so blended with the tissues as not to be displaced, and no further trouble ensues. It is on this account that the unavoidable delay of removing the seriously wounded from battle-fields becomes a blessing. In running over the field after a severe battle, those who, from loss of blood, have not the strength to cry for help, are left as mortally wounded by the members of the ambulance corps, who are busily engaged in carrying to the infirmary those whom they think require immediate attendance, and are likely to be benefited by treatment. When all of these have been removed, the battle-field is again gleaned for such as may be found alive after, perhaps, an interval of from twenty-four to forty-eight hours. The quiet of the battle-field has supplied to the severely wounded such treatment as they required, and under judicious care these cases often do well. Should such wounded be disturbed soon after the flow of blood had ceased, and be transported to the infirmary or general hospital, and especially if brandy be freely given to bring on reaction, the excitement which the pulse would exhibit, and the increased force of the heart's action, would displace the clots before they became firmly established in the site of the wound, and hemorrhage would reappear.

This renewal of the bleeding, as a variety of consec-

utive, is called retarded hemorrhage, and is simply a continuation of the primary hemorrhage, after an interval of a few hours' suspension, before the artery and surrounding tissues have undergone any material changes. Although a ligature upon the bleeding mouths of the vessel in the wound may be necessary to arrest this bleeding, when excessive and threatening the life of the wounded man, as a rule judicious pressure and the use of styptics are found adequate for its control.

In the ordinary course of gunshot wounds, suppuration is established about the fifth or sixth day, when the track of the wound commences to be cleansed of all those tissues which have been crushed and so much injured as to be no longer preserved among the living tissues. During the elimination of these destroyed parts, when the walls of blood-vessels are implicated, and where the precaution of rest and absolute quiet has not been enforced, hemorrhage, called secondary, appears. All injuries to large arteries threaten, sooner or later, to produce secondary hemorrhage. However large the artery reopened by this process, the escape of blood seldom occurs with an impulse, but usually flows away in a continuous stream, which is supposed to indicate its escape from the *lower* end of the vessel.

If hemorrhage has been arrested for a few hours, when even from the femoral artery, the efforts of nature are usually sufficient to prevent its return from the upper portion of the artery, although not from the lower end of the vessel; so that when the main artery of a limb is divided by a ball, should primary hemorrhage be controlled, the great fear is either from subsequent bleeding through the lower end of the vessel, or from mortification of the ex-

tremity. Any hemorrhage, after forty-eight hours, would be considered secondary, and would require special treatment; prior to this it would be called retarded or delayed primary hemorrhage. As long as the wound remains unhealed, hemorrhage may make its appearance; and it is not until a cure is effected, and the parts are cicatrized, that the patient is positively safe from this dangerous complication. Cases are recorded where it has occurred ninety days after the vessel had received injury; and a case of unusual interest has recently been reported by Surgeon S. E. Habersham, in the Confederate States Medical and Surgical Journal, for January, 1864, in which arterial hemorrhage destroyed life three hundred and twenty-eight days after the receipt of wound. The case was one of compound fracture of the upper third of the thigh from gunshot wound, in which a detached fragment from the femur finally caused ulceration in the femoral artery, and fatal hemorrhage occurred through existing fistulæ, which were still discharging.

Unless the causes of this hemorrhage be perfectly understood, the rules laid down for treatment will not be duly appreciated. In speaking of the action of the two ends of a divided artery, we have already stated that the upper end contracts vigorously, diminishes its calibre at the point divided, and for some distance up the tube, until it simulates in its proportions the neck and body of a claret bottle. The blood, impeded in its outward course, allows a clot to form, which, acting as a stopper, shuts up the open mouth. The clot of blood, as a plug, is continued in the contracted artery to the first collateral branch, and nearly fills this cylinder. The lower portion of the vessel, having been in a measure paralyzed by

the division of its coats, which had cut off its supply of nerves, acts with much less energy. The diminution of its calibre depends more upon the removal of distension from its elastic walls than from the contraction of its muscular fibres. The result of this paralysis is, a more or less patulous condition of the lower portion of the vessel in the vicinity of the injury; and as the supply of blood from above is cut off, there is but little arterial blood in it to clot and plug it up.

As soon as this barrier or clot is placed upon the main thoroughfare, at the upper wound, preventing the blood from following its accustomed channel, nature is at once busy, opening and enlarging the circuitous by-ways and alleys of the circulation, so as to restore the supply to the extremity threatened with starvation, or, in surgical parlance, mortification. (See figure 4, plate 14.) As when upon a high-road a bridge spanning a stream is destroyed, travellers seek a ford higher up by which they may return to the thoroughfare beyond the impediment, so the blood, taking the nearest by-roads above, soon gets around the obstacle, and empties itself into the main channel below it. The blood here changed in its direction, and not opposed by valves, passes up as well as down the limb, and finding an open gate at the lower torn mouth of the vessel, escapes. This fluid, moreover, in its roundabout course, has lost much of its vivifying properties; much of its oxygen is gone, and carbonic acid, ammoniacal gases and the like, having taken its place, mars its brilliant color, and diminishes its clotting properties. No proper material, therefore, exists for stopping up the vessel, as in the upper end of the divided artery, and the result is that secondary hemorrhage may readily occur from the lower end.

This being well understood, we can now explain why a ligature placed on the upper orifice alone, or on the course of the artery above the injury, should not always stop, but often only temporarily control, the hemorrhage. As soon as the collateral circulation above the ligated point is re-established, should the lower opening in the vessel remain as before, a sufficient interval not having elapsed for the gradual contraction and obliteration of the arterial tube, hemorrhage must recur, or, if this collateral circulation be not established, mortification must follow. *The rule which experience has established from these physiological and pathological facts is: ligate both ends of the vessel at the point wounded, as this is the safest course to pursue.*

Another strong reason why the ligature should be applied to the wounded ends of the artery is, that there is always some uncertainty as to the vessel injured, whether it be the main trunk or only a branch. The very serious and often fatal operation of ligating the femoral artery has been performed for an injury to one of its branches, which had not been suspected—a post-mortem examination revealing the source of hemorrhage. When the ligature is applied to the bleeding mouths, this accident can not happen.

A very interesting case in point, which brings the propriety of the above rule strongly into view, was that of Private B. Creecy, Company E, 42d Virginia regiment, who was wounded on the 3d of May, 1863, by a minie ball, which, in its passage through the larynx, above the vocal cords, carried away the epiglottis. On the twelfth, nine days after the receipt of injury, while under treatment in the Winder Hospital, a severe secondary hemorrhage came on, to control which the left common carotid artery was ligated. The hemorrhage ceased, to reappear on the eighteenth,

when the right common carotid artery was ligated, with the same effect of stopping the bleeding. The patient lived thirty-six hours after the second operation. An autopsy revealed the fact that the left hyoid artery was the injured one, and the inference is that a ligature to the artery at the seat of injury might have given a much more successful result, and obviated two very serious operations.

The course which should be adopted in the case of hemorrhage from an injured artery is as follows: After the hemorrhage has once been controlled, and through either carelessness on the part of the surgeon, or restlessness on the part of the patient, getting up to help himself when he had strict orders to the contrary, or perhaps from rough transportation over bad roads, or the sloughing of the wound, or by enfeebled health brought on by camp diseases or exposures in the field, etc., hemorrhage reappears, the limb should be at once bandaged from the extremity upward, making careful, regular pressure, so as to diminish the quantity of circulating fluid. Over the course of the main artery, and for some little distance above and below the wound, a compress, saturated or not with some of the styptic preparations of iron, should be firmly secured, the bandaging of the limb extending to one or two inches above the injury. The patient is then to be placed upon his back, the limb elevated, and an ice bladder applied over the wound. Absolute quiet should be enjoined, and secured by the free administration of opium.

In many cases this plan of treatment will bring about the desired object if persevered in for some time, and assisted by those internal remedies which control the force of the circulation, as veratrum viride and digitalis, in connection with such a course as will im-

prove the plastic character of the blood, viz: tonics, good food, etc. By the use of compresses saturated with the perchloride of iron, in connection with absolute rest, I have succeeded in checking secondary hemorrhage from the carotid artery after the escape of the ligature.

But should the parts be so situated that this pressure can not be applied for a sufficiently long time, or should it not control the bleeding, or should the bleeding recur, then the proper course is to attempt to save the life of the patient by a surgical operation. Ligate the mouths of the artery in the wound without further delay, if it be possible. If the artery can not be found at the point from which the bleeding occurs, then ligate it at some portion of its course above the seat of injury.

No case of secondary hemorrhage should destroy life by repeated recurrence; a surgeon is very culpable who thus permits life to ebb away from his grasp.

Surgeons can not be too much on their guard against the delusive attempts at stopping the bleeding by medication after the second recurrence of secondary hemorrhage. If the case is not operated upon the bleeding is sure to return, and as certain to destroy life, as experience has repeatedly proved. Every fresh hemorrhage increases the dangers and multiplies the risks. A rare instance may occur in which secondary hemorrhage, even three or four times renewed, has finally ceased, and the patient has recovered; but this would be a very dangerous example upon which to establish rules for treatment, as a very large majority of similar cases would be sacrificed to this procrastination. *The established rule, therefore, is never to neglect the ligation of an artery after the second recurrence of hemorrhage.*

You must not be deterred from placing a ligature on the open mouths of an artery in a suppurating wound, on the deeply grounded but erroneous idea that the artery has had its coats softened by this process. Practical surgery shows conclusively that but little pressure is required to close the vessel, and that the coats are tough enough to sustain a ligature in a suppurating wound. Therefore the rule should have no exception on this account. *When it is possible, ligate in the wound under any circumstances.* The swelling and infiltration of tissues renders the search after the injured artery difficult; but the surgeon who, looking to the side of humanity, considers it a sacred duty to do everything for the interest of the wounded, must not allow difficulties to interfere with his proper course. *Safety lies in this operation.* When possible, the difficulties must be met and overcome.

There are cases, however, in which these would be nearly insurmountable, where the hemorrhage occurs from an inaccessible artery located in parts which are very much swollen, and in a subject much prostrated by previous loss of blood. In such cases we are forced to ligate the artery at some point above the site of injury, where it can be found with facility and certainty, and where the tissues have undergone no material changes.

The following appearances will be observed in the wound, and will assist in the search: After dividing the infiltrated tissues, should the injury have been received over forty-eight hours—particularly if ten or fifteen days have intervened, which is the usual period for the recurrence of secondary hemorrhage—the ends of the vessel will be found incarcerated in the midst of a mass of greenish yellow fibrine, with blood clots of more or less recent origin. These indicate the

situation of the artery, the central being the softest portion of the clot corresponding to the orifice in the vessel. Where post-mortem examinations are made, in cases of death from secondary hemorrhage in which the clots of former hemorrhage have had time to be bleached by the absorption of the colored portions, a probe introduced into the artery from below would make its appearance at a point under the yellow fibrinous residuary clot, raising a thin portion as it protrudes. Should the patient have been destroyed by a hemorrhage, an opening will usually be found in this pellicle. Through the upper portion of the artery the probe would pass down with much more difficulty, owing to a contracted tube plugged with coagula—conditions which do not exist in the lower portion. These lymphy, yellowish green fibrinous masses are to be followed as our guides after the wound has been freely dilated.

The exact situation of the incision to seek the bleeding vessel will depend much upon the position of the wound. Should the ball have traversed in such a way as to render the track of the wound a short road to the vessel, the search would be made by dilating freely the wound. Where the ball has, however, traversed the limb obliquely, and the orifice from which the blood escaped is at some distance from the vessel, requiring an unnecessarily extensive incision to expose the artery, it would be much preferable, instead of dilating the existing wound, to pass a probe through the track made by the ball until it reaches, apparently, the immediate neighborhood of the bleeding vessel, and then make an incision parallel with and directly over the course of the artery at a point where the vessel is most superficial, and where its anatomical relations can be used as guides in the

search. If the incision be free, which it should always be, a healthy portion of the vessel, both above and below the bleeding or injured portion, can be exposed, and the pulsation in its course above the injury would materially assist the operator in finding the torn or ulcerated portion. As this operation may be called for in a case in which, should the search fail, it would be impossible or inexpedient to ligate the artery in its course above the seat of injury, the incision may be made in such a direction as would permit of an amputation being performed as a *dernier resort.* When the incision has exposed the vessel, a removal of the pressure from above, whether it be from a tourniquet or the finger of an assistant, will allow the blood to escape from the injured point.

In a surgical operation, especially in ligating arteries, never be cramped from the fear of making too large an opening; the error is always on the other side. Having found and ligated the orifices, the water dressing should be continued as before—care being taken not to apply it should the limb become cool and pale. This is not usually the case after ligations for secondary hemorrhage, as the return of the bleeding indicates a re-established circulation, which the ligature at the bleeding mouths can not now influence to the injury of the limb.

Should it be impossible to find the bleeding mouths, after a long and careful search, or should our experience teach us that, from the position of the wound, a search after the vessel at its wounded portion would, in all probability, be unsuccessful, then we will be reluctantly compelled to adopt the less satisfactory operation of ligating the artery above the wound—hoping it may obviate any further operation. Often this course succeeds in checking permanently the hem-

orrhage. The swelling and œdema of the limb rapidly subsides, the wound takes on healthy action, granulations spring up, and cicatrization marches steadily to the complete healing of the wound. In many cases, however, when this last plan has been adopted, a return of the hemorrhage necessitates a second ligature upon some higher point; and should this fail, as is often the case, amputation of the limb will be the only resort to save life. Amputation must be equally resorted to if, after the application of a ligature, the circulation not being re-established, mortification of the limb ensues. In either case amputate above the seat of the ligature, so as to ensure a supply of blood to the stump for its nutrition.

These are some of the dangers incurred when the surgeon does not adopt the only proper course to stop the trouble at its commencement. Military hospital statistics show heavy mortuary lists where this rule is not recognized and followed. As the ligature acts as a foreign body, and must come away, it is of little importance what is used for that purpose—a strong cotton, flax, or silk thread, fulfils all the indications required. When applied, it should not be interfered with until it has either come away of its own accord, or ten to fifteen days have elapsed, when cautious tractions might be attempted to hasten its removal.

Silver wire has been spoken of as ligatures for arteries. However well it may answer in fresh wounds, where union by the first intention can be obtained, it is quite out of place in suppurating wounds, when ligatures are applied for controlling secondary hemorrhage.

Punctured wounds, made by the bayonet or sabre, require similar treatment to gunshot wounds. If the history and appearances clearly indicate the char-

acter of the wound, there will be no need of probing for imaginary foreign bodies. Such wounds usually bleed more freely than gunshot wounds, but the hemorrhage is susceptible of control by similar means—pressure being preferred to ligation of arteries. The treatment should be cold water dressings—irrigation preferred. Protect the wound from air, if possible, by covering it with adhesive plaster or collodion, and *dress it as seldom as possible, compatible with cleanliness. Once* probing of such a wound should satisfy the curiosity of any surgeon. A frequent repetition of this meddlesome surgery, besides the needless pain inflicted upon the wounded man, *must end in mischief.*

Simple incised wounds, as sabre cuts, will be closed by adhesive plaster (or sutures, which are preferable, should there be any tendency to gaping), to be followed by the cold water dressing. Should the wound be not of a serious character, it may be left even without after-dressing—the little oozing from its edges, when drawn together by straps or sutures, dries into a scab along the line of wound, and excludes air with its pernicious influences. This permits of the remodelling process, and cicatrization is effected without suppuration.

Should a bayonet or sabre wound transfix one of the natural cavities, the internal injury may be rapidly fatal from hemorrhage, or the injury inflicted upon the contained organs may, sooner or later, lead to the destruction of the patient by visceral inflammation. Under ordinary conditions, when such wounds exist in the extremities, where no large vessels are implicated, they require no special treatment. It is a class of wounds not as frequently met with in military surgery as one would suppose. The sabre-bayonet, when plunged into the body among the viscera, leaves

but little work for the surgeon. Such cases seldom leave the battle-field alive.

When the ordinary bayonet has buried itself deeply in a limb, suppuration may appear in the course of the wound. Should pus be suspected, and fears exist that it may be pent up under a fascia, it would be necessary to dilate the wound to permit of its free escape. Under no other condition should a punctured wound, made by either sword or bayonet, be dilated, except to remove foreign bodies or to control serious hemorrhage, where it is necessary to ligate the open mouths of the bleeding vessel.

In gunshot wounds the swelling of the soft parts, which commences a few hours after the injury has been received, usually continues to increase until the completion of the fourth day, when it has attained its acme, with commencing suppuration. Should sloughing occur, it will show itself by the sixth or seventh. On the eighth or ninth day the slough has, in most cases, separated itself from the edges of the track of the ball, and in a few days more will have been disengaged. With the cleansing of the wound, when no complication with foreign bodies exist, the inflammation gradually subsides, the swelling diminishes, purulent discharge lessens in quantity, and the wound commences to contract. The middle portion of the track first closes, and with it most frequently the opening of exit, leaving a funnel-shaped canal, which diminishes from day to day, becoming more superficial, until no depth is left to the orifice of entrance. The wound cicatrizes with a depression, marking distinctly the nature of the injury which has been received. In the experience of many army surgeons the most dependant orifice heals last, without reference to the entrance or exit of the ball. Should the orifices, however, be

situate in the same place, the orifice of exit is usually the first to close. This is the ordinary course which gunshot wounds take when judiciously treated in good constitutions.

In the general treatment of gunshot wounds, interfere with the general health as little as possible. The commonly prescribed antiphlogistic remedies are, with but rare exceptions, *not* required. The endless list of emetics, purgatives, diuretics, and diaphoretics, to which some European writers still cling with wonderful tenacity, can, with decided benefit, be dispensed with.

Guthrie, who represents this class, in speaking of the inflamed stage of gunshot wounds, says that the treatment for subduing this should be active: "The patient, if robust, ought to be bled (if no endemic disease prevails), vomited, purged, kept in the recumbent position, and cold applied as long as it shall be found agreeable to his feelings; when that ceases to be the case, warm fomentations ought to be resorted to, but they are to be abandoned the instant the inflammation is subdued and suppuration well established."

The experience of Confederate army surgeons is decidedly averse to the use of any depleting agent. Active purging and vomiting is incompatible with that degree of quiet which we have laid down as a fundamental rule in the treatment of gunshot wounds. As suppuration is usually long continued, and debility, with a certain degree of emaciation, usually accompanies the progress of gunshot wounds, the disposition should rather be to harbor strength in order to support this drain, than to despoil the system. *The modern practice of support rather than depletion hastens convalescence, and is the only rational practice.*

General and local bloodletting are so seldom requir-

ed in the treatment of gunshot wounds, the patient having, in most cases, lost more blood than the system could conveniently spare, that we need not lose time by discussing these remedies as formerly used in the treatment of all diseases and injuries. Suffice it to say, that in military surgery *we are not called upon to use either of them* for the successful treatment of gunshot wounds.

Emetics, as such, are never required in the general treatment of wounds. When very small doses of the emetic preparations are given, they may be useful in inducing relaxation and for generalizing the circulation, in this way deriving the excess of blood from the wound. Small doses of tartar emetic may, with other remedies, form a good prescription in cases of excessive reaction.

Mild purgatives are in constant requisition, both for their detergent as well as derivative effects, and may be needed during the treatment of nearly every case of gunshot wound. The most commonly prescribed article is the compound cathartic pill of the pharmacopœia, although from the large list of mild purgatives ample opportunity is afforded for making a selection. As a rule, where the object of the purgative is simply to evacuate the bowels, without reference to exciting the secretion of any of the abdominal organs, I have always found that an enema which will act directly upon the rectum, causing it to discharge its contents, will give all the comfort desired. By its use we avoid the delay accompanying the administration of medicines, and the gastric disturbance always induced by their irritating effect while passing through thirty feet of intestine, before the desired evacuation can be produced. As it is always desirable in the treatment of wounds to impair the digestion as little as possible,

the enema, whether of simple water, cold or warm, or whether made more irritating by medication with table salt, epsom salts, soap-suds, etc., etc., will always be found a valuable substitute for purgative medicines.

The granulations of a wound are said to be a better index of the condition of the intestinal canal than the tongue, as they are much more readily influenced by any cause which induces an irritable condition of the system. Keeping watch over the digestive organs, preventing, by proper diet, any indigestible food from getting into them, while the excretions which empty into this great sewer are not allowed to remain and disturb the system, will be at all times judicious practice.

Diaphoretics and diuretics are the milder antiphlogistic and derivative remedies, which may frequently be required to quiet the pulse and equalize the circulation.

The ordinary febrile reaction, which so frequently follows the receipt of severe injury, should give the surgeon no annoyance *per se*. It is only a symptom — an indication of the extent of sympathy between the local irritation and the system at large. When, by judicious local treatment, the nervous excitement near the wound subsides, the pulse will *pari passu* lose its frequency and irritability. It is not a disease within itself, requiring to be especially treated.

In the general treatment of wounds, diet and rest are the two great remedies which, in by far the majority of wounds, even the most serious, are all that is required for successful treatment. Should there be an excess of general excitement, which a purge with a diaphoretic or diuretic is not able to quiet, we would administer to such one of that class of medi-

cines which is known to control the excitement of the circulation, quiet the brain, and act as a sedative upon the nervous system generally, viz: opium, hyoscyamus, conium, belladonna, digitalis, veratrum viride, gelsemiuum sempervirens, etc.

When local reaction is excessive, with great swelling and heat, there is a class of general remedies which might be given with advantage. They act by increasing the tone of blood-vessels, and thereby cause a contraction in their walls and diminution of their calibre. This curtails necessarily the amount of blood flowing through these temporarily diminished vessels, and therefore relieves congestions. Upon such remedies much reliance might be placed. Holding a conspicuous position among these are the mur. tinct. of iron, tinct. of belladonna, wine of ergot, etc. It is by contracting the blood-vessels to such an extent that a sufficient supply of blood can not be transmitted for the nourishment of distant tissues, that mortification follows the too liberal and long-continued use of ergot. By this property of producing contraction in blood-vessels uterine hemorrhages are checked, or the action of the gravid womb, with its immensely developed blood-vessels, excited. The entire profession have adopted the mur. tinct. of iron as nearly a specific against the fearful inflammatory reaction of erysipelas, in which disease it causes a rapid and permanent contraction of the distended capillary vessels involved. For stronger reasons, it is equally efficacious in simple inflammatory engorgements. Belladonna shows its general action by dilating the pupil—an effect explained by the change in the circulation of the blood-vessels of the iris. Its advantages in relieving injection of the blood-vessels of the eye are well known and largely used. It is spoken of as the

remedy for the rapid relief of congestion of the spinal cord. Although these are the individual effects of such remedies, they are not the specific action of these medicines. Their influence belongs to the economy; and in affecting all the tissues, those feel their influence most which are offending, as there would be the widest field for the remedy to show its common effects.

Inflammation is a perverted condition of the blood and blood-vessels of a part, which means a modified state of nutrition. Whenever a cause of local irritation exists, which creates a disturbing influence in the economy and depresses the vitality of a part, nature, ever on the alert to ward off evil, pours its pabulum of life into the injured portion, to counteract the pernicious effects of the injury. The depressing effects upon the nerves permit the relaxation of the blood-vessels and invite in the circulating fluid. The blood flows in, filling up all of the channels and interrupting the healthy circulation through the part, and by its accumulation produces still further depression.

There are two diametrically opposed means of correcting this condition and restoring health. One is, by reducing the amount of blood carried to the part which threatens to overwhelm the vital functions of such an inflamed portion of the body. This is effected by bloodletting, vomiting, purgation, abstemious diet, and the entire list of depletory or spoliative remedies, which weaken the enemy to such an extent as to allow of the part attacked successfully coping with the disease. But when the disease is conquered, the victory may be as disastrous as a defeat, a long, tedious convalescence being required to restore the patient to his former state of health. Experience has shown this destructive plan of treatment to be inju-

rious, and it has been, therefore, properly discarded for a much more preferable method. This consists in increasing the tone, both of part and system, by supporting agents, which strengthen the garrison, increase the vital powers residing within the tissues for resisting the encroachments of disease, and thus are enabled to drive out the enemy, however violently the attack may be made. These successes are attained with but little loss on the part of the system, which comes out of the fire unscathed. Our object, then, should always be to cure disease by using such remedies as will cause the least possible loss to the economy.

We have, therefore, abandoned the plan of starving wounded men, or, by the mistaken policy of a rigorous diet, to keep off inflammation. We look upon inflammation as always depressing in its character—nature requiring assistance from without to enable her to cope successfully with disease. We do not hesitate, therefore, as soon as the stage of reaction has passed, to feed the wounded with strong, nourishing diet, and also further to support the system by the use of stimuli. Whiskey has been freely given to our wounded, particularly during the suppurative stage, and with decided benefit. As the irregularities of camp life, especially during an active campaign, have a depressing effect upon all soldiers, which, although not apparent as long as they are capable of performing duty, shows its influence immediately when they are placed upon the sick-list, the above course of supporting treatment is particularly applicable to the wounded of armies.

In all injuries, were it not for an exquisitely sensitive nervous system, we would have but little systemic sympathy, and, therefore, but little personal annoy-

ance. In the inferior animals, where the sensibilities are of a low description, and where the various portions of the body are more or less isolated and not tied together by numerous cords of nervous sympathies, limbs can be torn off without deleterious effect upon the rest of the body, and without producing inflammation. These inflammatory tendencies are only observed as we advance in the scale of animal life, until we find in man a perfection of a nervous system, with its corresponding sympathies and susceptibilities to physiological as well as pathological impressions. If we could, by some metamorphosis in the nervous sympathies of man, temporarily establish a condition simulating the more primitive developments, we would diminish the dangers of local trouble; or if we could take possession, as it were, of the nervous functions, and reduce them to their lowest stage for extending sympathies, we could equally keep down irritation, and, to a great extent, jugulate the tendency to congestion, and, subsequently, inflammation.

Opium, by which we can effect this subjection, will ever be the greatest boon to the military surgeon. It allays both local and general irritation, annuls pain, soothes the mind, blunts the sensibility of the injured nerves, and quiets the tumultuous action of the heart. By its sedative influence upon the cerebro-spinal system it allows the sympathetic system of nerves to act in unrestrained vigor, and through it tone is restored to the muscular walls of blood-vessels. Under its influence there is no longer a local irritation inducing blood to the part, nor dilated and relaxed blood-vessels, permitting an increased flow of blood; and the result is that inflammation, which is intimately connected with a local congestion and a local irritation, is kept in abeyance. It is, therefore, a

remedy which should never be absent from our reach. Going on the field, the surgeon should have his haversack well stored with it for immediate use; and throughout the entire treatment of the wounded it will ever hold a conspicuous place. Of all the preparations of opium, morphine is, perhaps, the best article for wounded men, as it has lost in preparation some of those astringent properties which, as opium or laudanum, would produce too great a tendency to constipation.

The endermic method of using this remedy would prevent endless suffering on the battle-field or in hospital practice. When morphine is taken into the stomach, it is dissolved in the fluids there found, and then undergoes absorption. This takes place with greater or less rapidity, according to the nervous excitement under which the system is laboring. At times its absorption is very slow, and its effects upon the system, from the small quantity found in the circulation at any one time, very indifferent. Under other circumstances, when the absorbents of the stomach are apparently in a condition of temporary paralysis, with complete suspension of their function, very large doses are administered in vain to produce the soothing effects which naturally belong to the drug. It remains, perhaps, unchanged in the stomach. Under the same condition, if a much smaller dose, in solution, be injected under the skin of any portion of the body, the vessels seem to absorb immediately the fluid, and its full effects are obtained in a few minutes. The following cases will show the marked efficacy of the remedy when used hypodermically:

Mrs. C. had been operated upon for cataract by division of the lens. Violent inflammation ensued,

ending in the destruction of the eye, and for three days she suffered agony. Day and night she rolled about the bed in ceaseless torment, in spite of repeated doses of morphine. Finding that one-half grain every two or three hours produced no alleviation of her suffering, I tried the experiment of injecting one-third of a grain, dissolved in two minims of water, under the skin covering the sternum. A Wood's endermic syringe was used. Absorption was immediate: in two minutes she was relieved; in five, all pain had disappeared, and in ten minutes from the time of the injection she was sleeping soundly, after seventy hours of unmitigated torture.

Mr. T. had been suffering with articular inflammation of the right elbow joint, and for three weeks had suffered so severely as to be robbed of all rest. He visited Charleston, four hundred miles from his home, to seek relief. An injection of one-third grain relieved him of all pain in five minutes. After twelve hours' sleep he awoke much refreshed; and although a general soreness continued for some days, no acute pain was felt in the elbow from the time of injection.

Captain M. was accidentally shot in the neck with a Colt's pocket revolver. His head being turned, the ball entered the skin over the larynx, coursed downward and backward through the posterior triangle of the neck, and was found under the skin of the shoulder over the spine of the scapula, and was removed. Considerable swelling and extravasation followed, which, diffusing itself, discolored that side of the neck. Some branches of the brachial plexus of nerves must have been injured by the ball, as the patient was seized with violent pains shooting down the arm toward the fingers, and which, although never altogether absent, would increase to torture as evening advanced. Tow-

ard morning they would remit and allow of sleep, after a restless and painful night. Gum opium and morphine, in large doses, gave him no relief. The arm was so sensitive that he would not permit its being handled. One-fourth of a grain of morphine, in three or four drops of water, was injected under the skin of the shoulder; in five minutes all pain had left him, and his arm could be examined rudely without the slightest suffering.

Although other cases of gunshot wounds could be detailed in which the endermic use of morphine gave immediate and entire relief from pain, the above recital will suffice as proof of its decided usefulness.

By the use of this simple process, a new and extensive field for doing good is open to the humane military surgeon, and he who is the fortunate possessor of this talisman will receive daily the thanks and blessings of his suffering patients. When chloroform can not be obtained, I would suggest this mode of blunting sensibility, immediately before operations are performed or painful and tedious dressings are made. It will be found a good substitute, and one which will yield its full effects without delay or trouble. There are very few injuries requiring operation which do not demand the free use of opium. Narcotizing the patient immediately before the operation, and keeping him under its influence for some hours, is among the best means of preventing an excess of reaction. The rapidity of action when morphine is used endermically is a very great advantage on the field, where every moment is of value. For complete narcotism, where a sufficient quantity of morphine is used, five minutes are all that is required; while with chloroform we all know that, when under excitement, its inhalation is often extended to from twenty to thirty

minutes, and even longer—time which the surgeon in the field can not well spare. Judging from analogy, I should say that, under the narcotizing influence of morphine, operations should be much more successful than under chloroform—as the impression is more lasting, and the inflammatory sequelæ ought to be correspondingly in abeyance.

CHAPTER VII.

Complications which Arise during the treatment of Gunshot Wounds—Erysipelas, contagious and infectious character—Constant tendency to Debility—Treatment, General and Local—Hospital Gangrene; its appearances: how recognized; Causes giving rise to it—Thorough Ventilation necessary to successful treatment—Local Applications, Actual Cautery, etc.,—Pyæmia a rare disease in our country; symptoms—Theory of Multiplied Abscesses—Great remedy; Prevention by rigid observance of Hygienic Regulations—Local and General Treatment—Tetanus, characters; March—Rarity of cure in Military Surgery—Local and General treatment upon which most reliance can be placed—Woorara in Tetanus—Hectic, from long-continued suppuration—Permanent and Periodic Pains.

Erysipelas.—We have already examined, in detail, the causes of secondary hemorrhage, which is one of the most alarming complications that can befall the wounded. A second, which is equally alarming to both surgeon and patient, is *erysipelas*. This disease appears to revel in the depressing influences which follow armies, and sometimes, as an epidemic, attacks all wounds, ravages limbs, and makes a frightful list of victims. Although it frequently occurs as an idiopathic disease, its most common exciting cause in military hospitals is a wound.

Idiopathic erysipelas, which is often met with in isolated cases, and usually found attacking persons without wounds, is a diffused inflammation of the skin, most frequently seated upon the face, although it may show itself upon any portion of the body. A red,

swollen, glistening spot, accompanied by a sensation of heat, weight, and fullness, seems to encroach rapidly upon the contiguous surface, nearly visibly extending its outline. Its appearance may have been preceded by a chill, which is followed by lassitude, pain in the limbs, back, and head, quick pulse and furred tongue, loss of appetite, and nausea, often with vomiting. During the secondary, in the simple form of the disease, a moderate effusion of serum escapes into the subcutaneous tissue. Where this tissue is loose, as about the eyelids, the swelling from serous effusion becomes excessive. The limit of the redness is at times well defined, although usually it is gradually lost in the surrounding healthy tissue. After a continuance of a few days, if its tendency to spread is controlled by judicious treatment, numerous vesicles, containing a clear serum, appear upon the reddened surface, and are considered an indication of returning health. These burst, the fluid dries up, the skin flakes off, and with these phenomena the general symptoms gradually subside.

Gunshot wounds in patients debilitated by the many depressing influences of camp life, are peculiarly prone to attacks of erysipelas. The variety most frequently met with among such is the phlegmonous, or, as it is now called, the cellulo-cutaneous variety. After a premonitory chill it makes its appearance with violent inflammatory symptoms, intense swelling, tension, redness, pain, heat, and effusion, the affected part pitting on pressure. It extends rapidly from the wound as a centre, and soon covers a large area, accompanied by symptoms of inflammatory fever, with a dirty, foul tongue, and deranged gastro-intestinal secretion, generally constipation, although at times diarrhœa, the urine being scanty, high-colored, and

acrid. It will be remarked that the pulse, although frequent and full, has no strength; and general prostration ensues at a very early day. Often by the fourth day the hardened œdematous tissue in the neighborhood of the wound, although it is still highly colored, presenting a glistening appearance, already feels boggy when the fingers are pressed upon it, indicating the extensive formation of pus and sloughs under the skin. The wound usually gives outlet to these pent-up secretions.

As the disposition of the disease is not to localize itself, the effusion actively thrown out in the extent of tissues undergoes a conversion into pus, which leaves this matter disseminated in all the tissues where the effusion had taken place. It is in this manner that the extensive purulent dissection of limbs occurs; by which muscles are isolated, blood-vessels separated from the surrounding connections, bones exposed from their periosteum, joints opened, and with these a general destruction of cellular tissue, which may be pulled out from the wound in shreds or layers resembling strips of wet chamois leather. The extensive loss of support to the skin from the undermining and destruction of the subcutaneous tissues causes it to break down into sloughs, which make an opening for the escape of this accumulating fluid. Nature in its weakened condition can not stand this drain of its best nutrient material; and prostration, feeble, irregular pulse, dry tongue, diarrhœa, delirium, and finally coma, ends the scene. Or, should judicious treatment check its inroads, a tedious convalescence and a shattered constitution remain to the patient.

Erysipelas can always be recognized by its distinctive characters of widely extended local inflammation, with tendency to the rapid suppuration and sloughing of the wound.

The prognosis of this complication, in military surgery, is always serious, when it occurs after gunshot wounds, as the constitutions of the patients have been undermined to a certain extent by the hardships and irregularities to which all soldiers in time of war must submit.

In the treatment of gunshot wounds it must be remembered that erysipelas, which is a very serious complication, is often produced by a careless disregard of those hygienic regulations which are so essential in the proper organization of a hospital. Over-crowding, bad ventilation, and a want of cleanliness—a combination which produces a poisoned atmosphere—are frequent causes for its production and propagation; although it can not always be traced to the depressing effect of bad food or a vitiated atmosphere, as cases occur in private quarters where ventilation is perfect. As the disease is clearly contagious as well as infectious, the directors of military hospitals must be very careful how they permit a case of erysipelas to be introduced into a ward with wounded men—for inoculation will at once ensue; and when erysipelas has taken possession of a ward, it is with great difficulty eradicated. Its effects can be traced first upon contiguous patients, whose wounds, healing kindly prior to the introduction of this focus of contamination, now take on erysipelas. The system soon shows the depression under which the patient is laboring. Some further complication, with low visceral inflammation of either the membranes of the brain or lungs or intestinal surface ensues, and life is overwhelmed by this combination.

Erichsen, in his Science and Art of Surgery, mentions the following case in proof of the contagion of erysipelas, as having occurred in one of his wards at University College hospital: "The hospital had been

free from any cases of this kind for a considerable time, when, on the 15th of January, 1851, at about noon, a man was admitted under my care with gangrenous erysipelas of the legs, and placed in the ward. On my visit, two hours after his admission, I ordered him removed to a separate room, and directed the chlorides to be freely used in the ward from which he had been taken. Notwithstanding these precautions, however, two days after this a patient, from whom a portion of necrosed ilium had been removed a few weeks previously, and who was lying in the adjoining bed to that in which the patient with the erysipelas had been temporarily placed, was seized with erysipelas, of which he speedily died. The disease then spread to almost every case in the ward, and proved fatal to several patients who had been recently operated upon." If such be its tendency in civil hospitals, how frightful is its march among the wounded in military hospitals? Such cases should be kept exclusively to themselves, or they entail incalculable loss upon the wounded.

The antiphlogistic treatment of erysipelas, especially the phlegmonous variety which we are now considering, has for many years been abandoned; and he who attempts to cure erysipelas in military surgery by depressing agents, will pay dearly for his rashness. However violent are its symptoms, the surgeon must not be deceived. *It is a disease of marked debility;* the violence of its inception is only a mask, to be thrown off in a few days, and often in a few hours. When the plan of attack is so well known as it is in erysipelas, where a study of the natural history of the disease has invariably shown, in its march, certain and speedy prostration, the surgeon is highly culpable who does not commence with the earliest

treatment to build up and support the system, and thus prepare it to withstand the depression which is so sure to ensue, and which, if overlooked, will lead to such serious consequences.

Prevention is always more judicious than cure, and, therefore, our first care should be—by the strict observance of those hygienic regulations for ventilation and cleanliness, and against over-crowding—to keep the wards of a hospital with so pure an atmosphere as to give no encouragement for this low class of diseases to intrude. When a case appears, isolate it at once; give it the advantage of a large airy room with free ventilation, or, what is found still more satisfactory, put the patient in a tent in which air can be freely admitted, and use every precaution against contagion. The use of sponges, bandages, etc., required by such a patient, must be restricted exclusively to himself; for should the same sponge be used by a dozen wounded men, they would all be as surely inoculated. Fresh air is indispensable in the successful treatment of this disease. Leave all the windows open for thorough ventilation, even at the risk of catarrhal affections, which are trivial when compared to the serious character of the disease under discussion.

The treatment of phlegmonous erysipelas, ever having in view the steady, onward march of the disease to suppuration, sloughing, and prostration, unless a barrier is thrown across its path, should be, from the commencement, stimulating and supporting. This tonic course, which is equally successful in simple idiopathic erysipelas, is prefaced by some mild cathartic, to cleanse the bowels of impurities which rapidly accumulate in them, and to excite healthy secretions from the digestive organs. For this purpose, the

compound colocynth pill would be a good prescription, although a dose of castor oil or sulphate of magnesia would, in the majority of cases, fill every indication. Without waiting the action of this cathartic, from which only a moderate effect is desired, we at once prescribe what is now called the specific by many, and recognized as useful by all—the tincture of the muriate of iron, in doses of from twenty to thirty drops, in a wineglass of water every three hours. Besides acting as a general tonic, and also, through its mineral acid upon the liver, promoting the biliary secretion, it appears to affect more immediately the enfeebled and distended blood-vessels, producing a permanent contraction of their muscular walls and a diminution of their calibre, in this way relieving congestion, and preventing, to a great extent, effusions. I have seen it cut short a traumatic erysipelas of the face, after an extensive operation for cheiloplasty, in thirty-six hours from its appearance. The perchloride or persulphate of iron, in from five to ten drop doses, is preferred by some surgeons, while quinine as a tonic is also found useful.

In connection with the mur. tincture of iron, and of equal importance with it, is the liberal use of alcoholic stimuli and nourishing diet. Erichsen says: "I have seen the best possible results follow the free administration of the brandy and egg mixture, to which I am in the habit of trusting in the majority of these cases." Its liberal use will restore strength, soften the tongue, and remove delirium. When the skin is dry and harsh, mild diaphoretics should be used, and as anodynes are always required in the treatment to allay pain and to give sleep, Dovers' powders would be a valuable agent. By adopting this course of attending to the secretions, keeping

the bowels soluble, and by generous diet and free stimulation supporting the system, even from the very commencement, against that prostration which is certain, sooner or later, to show itself, this scourge in military hospitals will be most successfully controlled.

Considering the disease as one of marked debility, most reliance should be placed upon the general treatment. In the idiopathic form of the disease, the tincture of the muriate of iron, with attention to the digestive organs, is now considered quite sufficient to check the disease without the use of local remedies. The usual local treatment in simple erysipelas consists in painting the part inflamed, as well as the contiguous healthy surface, with tinct. iodine, or with a solution of nitrate of silver (two drachms to one ounce of water), or the part is kept bathed in a solution of sulphate of iron. Where it shows a disposition to spread, the healthy skin around the inflamed spot is covered with a narrow strip of blister plaster, or painted with a saturated solution of nitrate of silver. If the cuticle is destroyed by these applications, the extension of the disease is checked. All local applications should tend to relieve engorgement. In the early inflammatory stage of phlegmonous erysipelas, before suppuration is established, painting the limb with the perchloride of iron, or the tincture of iodine, or using compresses soaked with tincture of arnica, etc., would tend to promote healthy action. Cold water, by irrigation, or iced applications, would be as useful here as in any other engorgements, although their irregular application, with the sudden and frequent changes of temperature which accompany it, has caused cold water dressings to be accused of inducing erysipelatous inflammation. All of these applications

may be accompanied with the methodically applied roller, which will compress the limb, and, by its mechanical support, diminish infiltration and congestion, and relieve tension and swelling. Sugar of lead lotions are highly lauded. Free incisions are recommended by many surgeons to relieve the engorged vessels. They give great relief to the patient, but it is a question whether they do not increase the irritation and hasten the suppurative stage—an effect not to be desired, as the entire armamentarium of the surgeon is directed against the formation of pus.

When pus has formed (which will be recognized by the doughy condition of the parts, into which the fingers sink when pressure is made, and, a little later, by fluctuation), incisions should be made sufficiently free to admit of the ready escape of pus at the same time, parallel with the axis of the limb and also with the course of the main blood-vessels, so that these may be avoided. Stimulating water dressings should be continued, to hasten the elimination of the sloughs and diminish the amount of secretion. The tincture of arnica, spirits of camphor, Labarraque's chloride of soda, diluted with from six to ten parts of water, diluted pyroligneous acid, diluted tincture of iodine, or the persulphate or perchloride of iron, either pure or diluted, make excellent stimulating applications, exciting healthy action in the inflamed part, and checking the tendency to continued suppuration. Wherever pus shows a disposition to bag, it should be let out by incisions. As the skin, largely undermined, is liable to slough extensively, it should be supported by properly applied bandages, which, by diminishing the cavity within, will prevent the burrowing of pus, and cause the skin to adhere to the deeper parts as soon as adhesive action can be excited.

HOSPITAL GANGRENE.—Still another fatal complication, to which gunshot wounds are liable, is *hospital gangrene*—the name being significant of the cause of this pest, as it is rarely seen as an isolated disease without the crowded wards of a hospital. It is highly probable that, like the former diseases which we have just considered, it is a blood poisoning, depending upon a foul, infected atmosphere, operating upon a depraved and enfeebled constitution. It most frequently attacks those who have become debilitated by exposure, disease, want of proper food, intemperance, etc.; so that in a crowded hospital, when gangrene threatens to devastate the wards, you might select, in advance, the cases which will most probably be first attacked. At times, however, it engrafts itself upon all wounds, whether trivial or serious; whether in enfeebled or robust patients, and whether recent or newly cicatrized, the presence of a wound ensuring an attack. Many surgeons consider it a constitutional disease, occurring from a strictly local cause which is found within the walls of the hospital. All surgeons recognize its contagious as well as infectious character, and the facility of transmitting it by sponges or dressings used in common by inmates of a ward.

The facility with which the air of a ward, or even of a hospital, becomes impregnated with this poison, would show that animal exhalations, especially from those suffering under this disease, possess the power of diffusing it. Burgman reports that hospital gangrene prevailed in one of the low wards at Leyden, while the ward or garret above it was free. The surgeon made an opening in the ceiling between the two, in order to ventilate the lower or affected ward, and in thirty hours three patients in the upper room, who

lay next the opening, were attacked by the disease, which soon spread through the whole ward.

Guthrie confirms the above by his experience, which, he says, left no doubt upon the mind of any one who had frequent opportunities of seeing the disease, that one case of hospital gangrene was capable of infecting not only every ulcer in the ward, but in every ward near it, and, ultimately, throughout the hospital, however extensive it may be.

Both English and French surgeons in the Crimean war recognized the atmosphere as clearly the vehicle of its extension, and that its increase or diminution depended upon the more or less crowded condition of the wards, and the amount of ventilation. They also observed the certainty with which it increased when the same sponges were used indifferently for gangrenous and for healthy wounds. It may be considered a thoroughly contagious disease.

Those who observe the march of the healing process of wounds, without and within hospitals, know how easily the one is cured, and with what difficulty a tedious cure is obtained in the other. Where the exhalations from many suppurating wounds are concentrated in a ward, the cicatrization of all wounds, even the most simple, is retarded, and contagion of any kind readily propagated.

There are certain conditions of the atmosphere in cities under which hospital gangrene or sloughing phagedœna shows itself, where its appearance can not be attributed to over-crowding, want of care or cleanliness, nor to any appreciable cause. During the year 1863 we passed through such an atmospheric condition, when the phagedœnic sloughing of wounds was epidemic, and so general was this complication that even the small prick in vaccination would, in

some instances, become frightful ulcers, and even lead to the destruction of life.

In military hospitals, the hospital gangrene will be recognized by the following appearances: Although the patient may have recently shown feverish symptoms, with loss of appetite, yellowish or pale skin, dirty tongue, and deranged bowels, the first appearance of the disease is recognized in the changes which the wound undergoes, which has led many to believe it to be, at first, a local disease, in time infecting the system. The granulating surface of a healthy sore, about taking on this sloughing condition, becomes comparatively dry and painful. The laudible pus, which up to this time was formed upon the surface, disappears, and a thin, dirty, watery serum bathes the ulcer. The florid hue of the granulations rapidly disappears, and is replaced by a dirty gray or ash-colored slough, which fills the wound, and forms a pultaceous and adherent covering to the granulating surface. As this gray slough increases in extent and depth, accompanied by a severe burning pain and a sensation of weight in the part, the surrounding surface becomes œdematous, swollen, and of a livid red or purplish color. This engorged appearance of the contiguous skin always precedes the advance of the gray slough. The edges of the ulcer are abruptly cut, undermined, ragged, and partially everted, assuming an irregularly circular outline, irrespective of the form of the wound prior to its invasion. The gray, tenacious mass, being formed of the mortified tissue, and containing pieces of dead, blackened matter, holds its place and can not be wiped off, although it sways to and fro when any attempt is made to cleanse the wound.

The liquefaction of these mortified tissues soon commences, and a dirty, thick, highly offensive, irritating

fluid, produced from the putrefaction of the slough, escapes from the wound, diffusing a peculiar odor, which, when once smelt, will always be recognized. This is the poison which possesses such powers of infection when brought in contact with healthy wounds, and which, when inserted under the skin, as in vaccination, will soon produce a similar ulcer to that from which the fluid was taken.

Once the disease has fairly rooted itself, its ravages are extensive and rapid. One can nearly see the extending line of slough, as if the poisonous fluid, bathing the wound, possessed corrosive properties; and often in twenty-four hours large portions of the skin, cellular tissue, and muscles will have mortified, excavating immense, frightful, ragged cavities, from which strings of dead membrane hang, and in the bottom of which will soon be found destroyed ligaments and tendons, with exposed osseous surfaces. The areolar and cutaneous structures are the most readily destroyed; the muscular and fibrous tissues yielding more slowly, the nerves offering the greatest resistance to destruction. These changes in the wound and surrounding tissues are accompanied by a severe burning, stinging, lancinating pain.

Pari passu with this local destruction, the system is gradually or rapidly showing the influence of the poison. Although the symptoms may be at first of an inflammatory character, accompanied by a high fever, the pulse soon loses its strength but increases in frequency, the mind becomes peevish, fretful, and desponding, the tongue becomes dry and brown, the skin pale, and the countenance anxious. The pain accompanying these changes is often so severe as to deprive the patient of sleep and greatly depress his spirits. The febrile accompaniments of the disease rapidly as-

sume a typhoid cast, with every indication of physical and nervous prostration. Should the system become overwhelmed by the virulence of the poison, delirium ensues, and, with a tendency to coma, becomes a prominent symptom.

Should the case not terminate fatally before the elimination of the sloughs commences, the separation of these may open large vessels, from which hemorrhage will rapidly destroy life. The great nerves and arteries appear to resist the gangrenous destruction longer than the muscular or cutaneous structures. These, however, yield in the end, and repeated hemorrhages close the scene.

When, from judicious treatment or strength of constitution, the disease assumes a favorable turn, the sloughs are gradually thrown off, healthy pus making its appearance over the face of the wounds. Whenever laudible pus is seen in a wound which had been the seat of hospital gangrene, it may be considered as the sign that the disease has been checked, and a very strong indication of healthy action being resumed in the part. Granulations readily spring up over the entire surface of such cavities, pieces of dead tendon slowly coming away. When not sobbed in pus they become hard and black from exposure to air. The blackened surfaces of exposed bones also are slowly thrown off, by exfoliation, from the surface, and, in time, the most extensive excavations may fill up and cicatrize. With the local return to health is an improvement in the general symptoms, diminution and final disappearance of fever, improvement in strength of pulse, return of appetite, and, with it, color to the cheeks, and, more gradually, restoration of strength.

After the five bloody battles around Richmond in the summer of 1862 (the last days of June and first of

July), our wounded suffered fearfully from hospital gangrene in the hospitals of Richmond. Previous privations and hardships had broken down the physique of the army. Our soldiers had not yet become veterans inured to want, but were, on the contrary, much enfeebled by camp diseases and very short rations. Wounds from the Richmond battle-fields took on a sloughing condition at an early period, and amidst the destruction of tissue which followed more or less rapidly, arteries were frequently opened, and fatal cases of secondary hemorrhage were numerous.

I witnessed an epidemic of hospital gangrene in Milan, during the summer of 1859. A large number of Austrian wounded had been put in a barrack prepared for their reception. They had undergone many hardships, retreating daily before a victorious enemy, and had, prior to the Battle of Solferino, tasted no food for forty-eight hours. They had been deceived by their leaders, who had taught them that certain death awaited them should they fall into the hands of the Italians. With these impressions, the wounded hid themselves in the ditches and underbrush of the extended battle-field, where many perished. Some were not discovered for two or three days after the battle, when they were sent to the hospitals. The previous hardships which the Austrians had undergone, their lymphatic tendencies, their irregular living, with the moral depression of repeated defeat, exposed them to the ravages of the lowest forms of disease. Hospital gangrene raged fearfully among them, destroying numbers. Many of their wounds were frightful from the extended sloughing, and their worn frames and gaunt visages indicated a fearful combat with disease. I was particularly struck with the mental depression under which many of them were suffering—amounting

to despondency. This was further increased by the attendants and surgeons not speaking the German language, so that neither could their wants be known nor could sympathy be extended to them. From the combination of these depressing causes, an epidemic of sloughing phagedœna appeared, which was appalling even to those accustomed to see disease in its most fearful form. In some, the muscles forming the calves of the legs had sloughed out, leaving frightful cavities; while in others, such was the destruction among the muscles of the thigh, that one could look through the limb.

McLeod tells us that, in the Crimea, during the heat of the summer of 1855, not a few of those operated upon were lost by a gangrene of the most rapid and fatal form. All of those attacked by it were carried off. In the case of a few, who lived long enough for the full development of the disease, gangrene in its most marked features became established; but most of them expired previous to any sphacelus of the part, overwhelmed by the violent poison which seemed to pervade and destroy the whole economy. "The cases of all those who died in my wards seemed to be doing perfectly well up to sixteen hours, at the furthest, before death. During the night previous to death the patient was restless, but did not complain of any particular uneasiness. At the morning visit the expression seemed unaccountably anxious, and the pulse very slightly raised, the skin moist, and the tongue clean. By this time the stump felt, as the patient expressed it, heavy, like lead, and a burning, stinging pain had begun to shoot through it. On removing the dressing, the stump was found slightly swollen and hard, and the discharges thin and gleety, colored with blood, and having masses of matter, like gruel,

occasionally mixed with it. A few hours afterward the limb would be greatly swollen, the skin tense and white, and marked along its surface by prominent veins. The cut edges of the stump looked like pork. Acute pain was felt. The constitution by this time had begun to sympathize. A cold sweat covered the body, the stomach was irritable, and the pulse weak and frequent. The respiration became short and hurried, giving evidence of the great oppression of which the patient so much complained. The heart's action gradually and surely got weaker, till, from fourteen to sixteen hours from the first bad symptom, death relieved his sufferings."

In the treatment of hospital gangrene, we must consider it frequently a local disease, with rapid tendency to constitutional poisoning. One of our early duties would be to destroy the accumulating poisonous ichor in the wound to prevent further infection, while, at the same time, we correct those depressing causes which predisposed to the disease. Guthrie says that constitutional treatment, and every kind of simple, mild, detergent applications, always failed unless accompanied by absolute separation, the utmost possible extent of ventilation, and the greatest possible attention to cleanliness; and not even then, without great loss of tissue in many instances.

The local remedies which are found most useful act as caustics, and comprise the most energetic of the pharmacopœia. The French and German military surgeons prefer the actual cautery to all other applications to check the encroachments of the disease, although Armand even speaks of this remedy, upon which much reliance was placed, as exceptionally checking the progress of mortification. "After a thorough cauterization the eschar separates rapidly, and

often exposes a second infected surface of greater extent." His individual experience gives the preference to tincture of iodine as a local application. The best results were obtained by him when a compress saturated with this tincture was applied to the wound.

Guthrie recommends the liberal use of the concentrated mineral acids, especially the fuming nitric acid. McLeod refers to the nitric acid as the most efficacious means of stopping the sloughing process.

In our extensive experience we do not hesitate to give preference to strong nitric acid, which, when thoroughly applied to every part of the wound, will check the advance of the sloughing process. As the application, when properly done, is an exceedingly painful operation, the patient should have previously had a large dose of opium, or chloroform should be inhaled. The entire surface of the wound should then be thoroughly mopped with a dossil of lint saturated with the strong acid, which should be allowed to run in along the sinuosities of the wound, so that every portion of the exposed surface might be converted into an eschar, and all the existing fluids of the wound be destroyed by the action of the acid. One thorough application will suffice to control any case of hospital gangrene, and, if accompanied by judicious treatment, will not require repetition. Half-way measures, it must be remembered, will be trifling with the life of the patient. The surgeon must not be deterred, by the fear of giving pain, from making a thorough application of the caustic. The after-treatment of the wound consists in the use of charcoal, flaxseed, or meal poultices, rendered stimulating by an admixture of pyroligneous acid, turpentine, or creosote, or, what is far preferable, lint, raw cotton, or old soft cloth, saturated with solutions of either of these fluids, as it makes a

much cleaner, equally useful, and more convenient application. When the sloughing tissues have separated and granulations have freely sprung up, warm water dressings can be substituted.

To show the confidence placed upon the judicious application of strong nitric acid, I will quote a few lines from one of many reports forwarded to the Surgeon-General's office by the chief surgeons of hospitals. Surgeon Chamblis, of Camp Winder hospital (an institution of three thousand beds), speaks as follows: "Nitric acid has been applied in every case of hospital gangrene which has occurred in this hospital during the past year—in every case with benefit, and in most cases with prompt and decided success, which may always be expected as the result, if properly applied."

In some hospitals the persulphate of iron, which is a powerful acid astringent and cauterizing fluid, applied with similar care, was found equally efficacious, and is spoken of as establishing a slough which, when thrown off, leaves a clean, nicely granulating surface. It thoroughly destroys all the putrescent tissues, making a dark, pultaceous, inodorous slough, which can be removed by syringing, and which will separate in thirty-six to forty-eight hours, leaving a healthy surface. This application does not destroy or excite surrounding tissues, as is the case with the more violent nitric acid or actual cautery. Strong pyroligneous acid, when poured into the cavity of the wound, was found, in many cases, to be followed by equally satisfactory results, although in a number of instances it did not check the progress of the disease.

Labarraque's chloride of soda, creosote, perchloride of iron, lemon juice, oil of turpentine, a combination of quick-lime and coal tar, etc., have been also used with

benefit; but general experience in military surgery gives decided preference to the mineral acid preparations. These may be followed by irrigation or frequent syringing, which wash away the ichorous discharges as rapidly as they form, and prevents further infection; also, some soothing application should be made, containing stramonium, conium, morphine, or some anodyne preparation, in solution, to allay the agonizing pain in and around the wound.

The local treatment alone, without the constitutional, would be followed by no good results. As *hospital gangrene* appears pre-eminently to reside *in over-crowding, the most important of all the constitutional remedies is change of air.* If the patient could be removed from the atmospheric influences of the infected ward, his chances for recovery would be greatly increased. Baudens states that without isolation all treatment will show itself powerless, and our experience has confirmed the importance of ventilation. An established custom in the organization of a Confederate military hospital is to have attached to the same a number of tents, to be used especially for the treatment of erysipelas and hospital gangrene. Whenever hospital gangrene shows itself in a wound, the patient is immediately removed from the ward to an airy tent, where the thorough application of nitric acid is made to the wound, and, under the general supporting plan of treatment, improvement appears to show itself immediately. Under this generally adopted course of treatment hospital gangrene, the frightful scourge of European military hospitals, has been robbed of all its terrors. *Fresh air is the great remedy.* Every day, when the weather permits, the sides of the tent are tucked up, so as to allow the free circulation of air. Cleanliness must be insisted upon. Quinine,

or the muriated tincture of iron, is administered as a tonic—brandy or whiskey freely used—strong, nutritious food given *ad libitum*, and we expect the patient to recover. Rarely are we disappointed in establishing a cure.

Keeping the intestinal action free by a little blue mass, or compound extract of colocynth, will be required.

Opium is required in every stage of this disease, and is administered in large and repeated doses to allay the pain, irritability, and sleeplessness which so generally attend the severe cases of gangrene. The diet throughout should be highly nutritious, and should be liberally prescribed. Although wounds, under the influence of hospital gangrene, assume frightful appearances, the inexperienced surgeon can not be too urgently warned against amputating limbs, unless driven to it to save life, from the disastrous effects of frequently recurring hemorrhages. The stump will at once take a similar condition of sloughing, and soon a more extensive ulcer than the one for which he amputated will show him that he has risked the patient's life, by a serious operation, without having improved his condition.

Pyæmia, a disease very common in Europe, and a scourge of their military hospitals, was but seldom met with in the Confederate States until it became necessary to mass large numbers of wounded in crowded and badly ventilated wards, as after the many bloody battles of the past three years. When it shows itself in European hospitals, like its kindred disease, erysipelas, it is not satisfied until it has swept off its hundreds. After the battles of the Crimea those requiring amputation were severely afflicted by pyæmia,

nearly one-fourth of those operated upon being carried off by this frightful scourge. In civil hospitals it is not the less frequently met with, as we are informed by European writers that it destroys forty-three per cent. of all fatal primary amputations and twenty-five per cent. of all fatal secondary amputations—ten per cent. of all amputations dying from pyæmia. In some of our military hospitals it has proved fatal to several of our wounded; at no period, however, has it appeared as an epidemic, with its hundreds of victims. During the years 1862 and 1863, before buildings were especially erected for military hospitals, and when houses, however badly suited, were, from necessity, used as wards for our wounded men, we find but fifty-two cases of pyæmia reported by army surgeons. At the same time fifteen hundred and seven amputations of large limbs were reported as having been performed from October, 1862, to October, 1863—only a portion of the interval referred to above. Although this number is not supposed to represent every case that occurred during that period, it is, nevertheless, sufficiently near the truth to show that, comparatively, it is a rare disease in the Confederate army. Of these fifty-two cases but one cure is reported, which also indicates that it has lost none of its malignancy when contrasted with its European fac-simile.

The great similarity in causes, symptoms, and effects, are sufficient grounds for associating this with the large class of æsthenic diseases, among which erysipelas and hospital gangrene are prominent. It is impossible to control the symptoms and prevent a fatal issue, when, as acute pyæmia, it seizes upon the wounded in military hospitals; it is, therefore, much more to be feared than its kindred diseases just mentioned. Although this disease is always associated

with injuries, no wound, however trivial or however well advanced toward cicatrization, is safe from its attack until completely healed. The disease is supposed to be caused by a vitiated condition of the atmosphere from over-crowding in badly ventilated wards, and by the absorption of the ichorous fluids decomposing in the wound, which produces a general poisoning of the blood, rendering it unfit for sustaining life. It has been called an acute decomposition of the blood.

The most conspicuous phenomena which accompany this affection are, great depression of the powers of the system, and the formation of abscesses in various parts of the body. In the incubative stage, which may precede the explosion of the disease by twenty-four or thirty-six hours, the patient is restless, anxious, ill at ease, with forebodings of impending trouble. He looks pale and sallow, has loss of appetite, and generally deranged secretions. The disease commences by severe chills of long duration, which, in the acute cases, are repeated with much irregularity. In the subacute variety these chills appear at such regular intervals, followed by high fever and terminating in profuse sweats, as to induce the belief of the existence of malarial-fever. In many cases the skin is hot, with a pungent feel, irrespective of the chills; in others the chilly and feverish sensations alternate, the skin being at times clammy and often jaundiced. The pulse is quick and feeble; face pale, with anxiety of countenance; tongue foul, with a tendency to become dry, and for sordes to collect upon the teeth; the stomach is uneasy, with bilious vomiting, and constant thirst. The suspension of secretions gives a dull, yellowish, icteric tint to the skin.

As the pulse becomes more and more enfeebled, the

patient may complain of pains in his joints, simulating rheumatism, and, simultaneous with these, a reddening of the skin, with swelling of the joints. Collections of a purulent character will soon after be detected, distending the synovial sacs. Collections also occur in the cellular tissue, and even in the substance of organs. These form rapidly and without much inconvenience. Often the swelling alone—which has appeared during the night, unaccompanied with pain, redness, or heat—indicates that a large collection of pus has already taken place.

While these symptoms progress, the wound usually becomes foul and sloughy, ceasing to secrete pus. This is not the invariable rule, as surgeons have noticed cases in which the appearance of the wound was no indication of the destructive disease which had laid its relentless hand upon the injured. The disease may even run its fatal course without material changes in the wound. Certain injuries are more likely to be followed by pyæmia; and those of bones and joints are said to be peculiarly exposed to it. As in the kindred diseases of low type, typhoid symptoms ensue at an early day, and usually carry off the patient at the end of the first week. Often stupor comes on as early as the fourth day, having been preceded by delirium. An examination after death will reveal a rapidly advancing decomposition, with gas in the blood-vessels and purulent collections in many organs, as the lungs, liver, spleen, kidneys, heart, and brain. Similar collections are found in most of the large joints, besides the multiplied abscesses of the cellular tissue.

The theory of the metastatic character of the abscesses, or the sudden change of place of such deposits, by absorption and redeposit, has long been abandoned. Pus we now believe to be a modified

nutrient fluid, which, from an impairment of its vitalizing principle, falls short of its object of repairing tissues. During the healthy action of living tissues they are constantly bathed in a plastic fluid which they draw from the blood-vessels for their support. Under ordinary acute inflammation this exudation of plasma is freely drawn by excited tissues, which are not able to consume the excess of nutriment which they have taken from the circulation. This plastic fluid, now at rest without the blood-vessels, and not being used for the nourishment of the affected tissues, attempts a formation of its own, developing cells in this plasma which simulate closely the white cells in the progressive development of the blood, and which are supposed by some pathologists to be identical with them. The effused fluid exhausts its developing vitalizing power in this creation, and all further changes in it are of a retrograde nature. This cellular fluid is pus. When, from some special cause, the entire circulating fluid has become poisoned, its entire plasma or liquor sanguinis is impaired. It is from this plasma, under ordinary conditions, that the blood-cells are to be generated. The usual process of development is commenced, white cells form as colorless blood corpuscles, and when the continued development into the red or perfect cell is attempted, many failures occur. There are, besides, many which had exhausted their formative powers in attaining the degree of development necessary to perfect the white cell, and remaining as such, continue in the circulation. When the blood of a pyæmic patient is examined, a very large number of such colorless cells are found in the blood, even in sufficient quantity to modify its color, and it is in autopsies that the separation of these white cells from the generating fluid

shows the appearance of pus in the blood or emboli in the large vessels at the heart.

Blood in this condition, with an impaired liquor sanguinis, is unfit for its duties as a life-supporting fluid. The various tissues of the body, not receiving the kind of nourishment appropriate for their healthy function, become irritated. Nature tries to make up the deficiency in quality by quantity. The irritated parts are supplied with an excess of the impaired nutritive fluid, which, being eliminated from the capillaries, is received into the tissues. This is rapidly converted into pus, by the development of white or colorless cells in it, which is the height of vitality in such an exudate.

Experience, which helps to sustain this view, shows the disease to be purely a blood poisoning—a general disease, with its local manifestations. When the blood has been thus thoroughly deteriorated, no remedy which art possesses can restore it to its former healthy condition, and the patient necessarily dies—there being no case of acute pyæmia which has ever been reported cured.

As there is no course of treatment for acute pyæmia which promises any good results, we must direct our energies where they can really be useful. Our great remedy lies in prevention. The hygienic precautions of rigid cleanliness, *thorough ventilation*, good food, and proper shelter, *without over-crowding*, will, if properly insisted upon, go far to keep away, if they do not altogether prevent, the occurrence of pyæmia. When this disease threatens, too much attention can not be paid to the detail of cleanliness in the wards. The slop-buckets, which are such a niusance, should be immediately emptied, scoured daily with lime, and always kept covered, that the emanations arising from de-

composing urine, which is very deleterious in hospital wards, can not escape. The bed and body linen of the patients should be daily changed; doors and windows must be kept open. If any difficulty exists in this respect, from the inattention of nurses or fears of patients, it would be better to take out the sashes, so as to ensure continued renewal of the atmosphere day and night.

There is a general dread of night air among our people, which should be exploded. The purest air we have in cities is the night air, and is the very article which is so much needed in hospitals. If the patient is properly covered in bed, there is no fear of his taking cold or contracting other injury from the continued renewal of pure air. Men who live in the open air, and are protected by no other roof than the arched sky above them, never have catarrhal affections. These precautions must not be commenced when pyæmia has already shown itself, but are those necessary to be taken wherever the seriously wounded are treated, or some low form of fatal disease will soon break out. Any one who will visit, during the night, a ward filled with suppurating wounds, will perceive the degree of vitiated air which the patients are inhaling, and see the necessity for free ventilation.

It is a bad principle to concentrate the seriously wounded; always scatter them over a building, mixing them in with inmates from other diseases. This increases the available space for the seriously wounded, and prevents a depressing effect, by diffusing the emanations from so many extensive suppurating wounds. It is for a similar reason that we have already recommended that rooms should not be kept too long in use when occupied by the severely wounded. As the air becomes poisoned, the ward requires

to be unoccupied, for purification, two weeks of every two months, during which interval it is thoroughly cleansed and whitewashed.

When pyæmia threatens to become general in a military hospital, *the seriously wounded should be put in tents*, or allowed double space in a constantly ventilated room. Sixteen hundred cubic feet would not be too much for every occupied bed. An additional quantity of nourishing food should also be given out to all the wounded; besides which, whiskey or malt liquors should be daily issued. Feeding the wounded on light broths and other slops is paving the way to the debility which is a precursor of pyæmia. At such times, when pyæmia makes its appearance, all small operations should be avoided, and even the hasty opening of abscesses guarded against. *The best protection against this disease is a whole skin.*

When the acute form of the disease shows itself, surgery can do but little to assist the patient. More benefit will be derived from changing the patient into fresh air than from any other remedy; and, if he can be saved, it will only be by putting him in a tent in which he can be constantly surrounded by an ever-changing atmosphere. Our entire reliance should be placed upon the stimulating tonics. Strong, nutritious, easily-digested food, the free use of stimuli, with opium to allay pain and restlessness, are the remedies indicated. The tendency to delirium should not prevent the free use of this last remedy, for although it would increase the difficulty if it be given in inflammation of the brain or meninges, it allays pain, removes restlessness, stops muttering, and induces quiet sleep, when given in cases of debility accompanied by delirium. As in erysipelas, the acid preparations of iron, as a blood tonic, may be administered with advantage.

Although so little is to be expected in the acute form of blood poisoning, in the subacute or chronic pyæmia much benefit will be derived from rigidly pursuing the course of treatment just marked out. By the stimulating and supporting plan, *with change of air*, many patients, after a long struggle, may be saved.

The important indication for local treatment in pyæmia is to prevent, by cleanliness, the accumulation of putrescent fluids in the wound, and by the frequent application of chlorinated washes, which also remove fœtor and stimulate the granulating surface. The abscesses which form during the march of the disease should not be too hastily opened, as this course, pursued with the numerous collections, will induce rapid prostration.

It is thus seen that the three most fatal complications to gunshot wounds are the three kindred diseases—erysipelas, hospital gangrene, and pyæmia—all recognizing a common origin, viz: imperfect ventilation, and want of proper attention to cleanliness, with the absence of those hygienic regulations necessary for the health of an army.

With proper care from the medical corps, these diseases, which are the chief scourges to the wounded, and the causes of a large percentage of deaths, can be in a measure, if not altogether, prevented.

Once they have made their appearance in a hospital, they will never be got rid of until the building is closed, and the proper measures for purification resorted to. Prevention, in this instance, as in all others, will be found better than attempts at cure, as many of these diseases, once they appear, are found quite unmanageable, and tend naturally to a fatal issue. All of these diseases are benefited by the isolation of the patient in a pure atmosphere, when the infectious character of the disease is counteracted.

and the patient is in the best condition for successful treatment. *In all of them the antiphlogistic treatment can not be too severely condemned.* The supporting plan, with stimulating tonics and liberal diet, is the only rational course that promises success, and should be followed throughout the treatment. Attending to the secretions with mild remedies, allaying pain, and inducing refreshing sleep by means of opium, good, strong, easily-digested food, and due regard to hygienic regulations, will be the course of practice to be pursued.

Hectic Fever.—The not unfrequent sequela of severe gunshot wounds is long-continued discharge, producing emaciation and hectic, with its gradual dissolution of body and soul. It is not at all surprising that the daily discharge from a wound, when at all profuse, should cause debility, as we have already characterized pus as the nutritive essence of the circulating fluid. If the surgeon who has suppurating wounds under his care overlooks the fact that he must make allowance for this drain, and feed the wound as well as the patient—the wound being more imperious in its demands than the economy, deprives the latter of its due supply of nourishment, and progressive starvation, which we call emaciation, must follow. It is on this account that what is called the antiphlogistic treatment, when fully carried out in the treatment of suppurating wounds, is so injurious, and that the supporting plan is required.

With diet, we have a powerful weapon for weal or woe in surgical practice. Soon after injuries have been received, when reaction runs high, by abstemiousness we can do much to quiet excessive irritability. But as soon as this stage has passed, and sup-

puration has become established, then the course of diet should be modified. Now liberal diet is necessary to prevent that febrile complication which, in the early stage of the wound, abstemiousness controlled.

The use of an abundance of strong, nutritious food, with stimuli, by enriching the blood, will increase the vital properties of the plasma, improve the tone of the tissues, stop the excessive demands of the irritated wounded parts, and diminish the drain. This treatment, with the liberal use of the astringent tonics, especially the preparations of iron, the use of cod liver oil, and the injection of stimulating astringents into the wound (as nitrate of silver, ten grains to one ounce of water, or tincture of iodine, or the acid tinctures of iron diluted, or pyroligneous acid, one part to five of water), will gradually diminish a discharge which, under less supporting treatment, would continue for a much longer period. The economy can not withstand this constant drain of pus. As its nutrient fluid escapes from the wound, the system becomes irritable in its weakness. In its efforts to throw off this yoke, it still further enfeebles itself. Daily fevers, with their profuse sweats, reappear with fearful regularity. Finally the blood becomes so poor that it deteriorates even more rapidly. The effete matter or useless material which is rapidly accumulating in the blood, and which is ejected from the circulation, irrritates the organs through which it passes, causing diarrhœa, and also copious deposits in the urine. This quadruple drain from wound, skin, bowels, and kidneys, can not long be resisted. Debility daily increases, the patient rapidly wastes to a living skeleton, having literally melted away, and at last dies from sheer exhaustion—the conjoined result of malnutrition and wasting discharges. **Such is hectic fever.**

TETANUS.—Another fatal complication of wounds, depending, however, upon very different circumstances from those recently considered, is *tetanus*, or lockjaw—a disease fearfully malignant under any circumstances, and, with very few exceptions, in military surgery. Fortunately, this is never an epidemic, nor can it infect a hospital, although pathologists have recently attempted to prove its origin traceable to an animal poison. This disease, although comparatively common among our negro population, has but rarely been met with in military practice, and is not more frequent among our wounded than it is in Europe, where it is rarely met with. In the Crimean service McLeod mentions but thirteen cases as occurring in camp and in the hospitals.

This disease, which does not depend upon the size of the wound from which the patient is suffering, appears to be caused frequently by sudden atmospheric changes in connection with dampness. Larrey, in his experience both in Germany and Egypt, found it in those wounded who, after sustaining great exertions during the fight on a very hot day, were exposed to the cold, damp night air on the field without shelter. After the Battle of Bautzen, where the wounded were left on the field during the night, exposed to severe cold, Larrey found on the following morning that more than one hundred were affected by tetanus. No such effects have followed the leaving of wounded soldiers upon the battle-fields of the Confederacy. In the thickets which cover the face of the country, and in which battles often rage, some of those who fall escape the observation of those in search of them, and remain two and three days exposed to the elements. Such wounded we have not found more liable to tetanus than those immediately cared for. In very hot climates it

requires but little excitement to produce it—a trifling puncture or scratch is, at times, sufficient to cause an attack; and it has been noticed by military surgeons that the scraping of the skin by a ball, with bruising of the nerves, is more liable to this complication than the more severe wounds.

The proximate cause appears to be some injury to the nerves, not necessarily connected with an open wound, as it has been known to follow the blow of a whip or a sprain. Wounds in certain situations are thought to favor its appearance, viz: injury to the hands, feet, joints, etc. It may occur very speedily—a few hours after the injury has been received—or it may not occur for days. Rarely does it complicate chronic wounds after the twentieth day. Its common period for appearing is between the fifth and fifteenth day, when, perhaps, the simple wound has completely cicatrized.

The premonition of uneasiness on the part of the patient, with vague fears of impending trouble, disturbed digestion, etc., are not often observed. Usually the first symptom which we recognize is a complaint of soreness of the throat, which in ordinary cases precedes, by some hours, the contraction of the muscles of the jaw and pinching of the features. This symptom is often mistaken for a common sore throat connected with some catarrhal affection, and is treated accordingly—the true character of the symptom being usually overlooked. The spasm, instead of commencing in the injured part, usually shows itself first in those muscles supplied by the fifth pair of nerves; and although, in sudden and violent cases, the spasmodic contraction of the muscles generally may rapidly follow the locking of the jaws, or appear to be even simultaneous with it, they are rarely found to

precede it. The locking of the jaws; the contraction of the muscles of the neck, especially the sterno-cleido-mastoids, which, by bounding under the skin, accurately defines the triangles of the neck; the painful sensation of tightness about the ensiform cartilage, as if the chest were in an iron coil ever contracting; the hardened condition of the abdominal muscles, with knots forming over the region of the recti muscles during the paroxysm of spasm; the stiffening of the muscles of the legs, while those of the arms remain free; the sardonic expression of the face, with drawn mouth and pinched features; clear intellect; sleeplessness; extreme restlessness; profuse sweating; incessant desire to drink, and extreme difficulty in accomplishing it; the occurrence of paroxysms of violent muscular contractions every few minutes, with loss of strength in the pulse, and rapid prostration—define so accurately the disease that it is one most easily recognized.

Any one who has ever felt a cramp in the calf of the leg, may have a faint appreciation of the intense pain which a permanent and violent cramp of all the muscles of the body must produce—a pain sufficient to destroy life promptly, through nervous exhaustion.

The prognosis of this disease is so serious, and the treatment, however conducted, so unsatisfactory, that many surgeons of large experience have never had a case of traumatic tetanus to recover under their treatment. That fruitful source of information, pathology, gives us no instruction in this disease. An autopsy reveals to the eye nothing commensurate with the intensity of the symptoms. A slight congestion of the spinal cord and medulla oblongata is all that can be discerned. From the symptoms, we judge of the disease as one of intense nervous irritation. Recognizing

the exhaustion which so soon and with such certainty shows itself, the treatment, as laid down by the most recent authors, and the one now generally adopted, is one of support to both the nervous and muscular systems.

Larrey has cut short the disease, in its incipient stage, by amputating the limb, or dividing the nerve which is supposed to be at fault. Other surgeons, by isolating the irritation, have been equally successful. Such results are, however, rarities in practice, the operations nearly always failing even when performed simultaneously with the very first symptoms, and always when the disease becomes confirmed with general spasms. At times, patients suffering from tetanus get well under the most varied treatment. Nearly every powerful remedy in the pharmacopœia has been recommended as a sovereign cure by those who may have derived some benefit from such in the treatment of tetanus. Disappointment is sure to follow the confidence placed in any of these articles. The most judicious course is to disclaim all specific remedies, and be guided by the symptoms. Allay, if possible, the intense nervous excitement, and the local cause of irritation by which the disease is occasioned, and support the system against the ensuing exhaustion, both by sustaining the patient's strength with strong, easily-digested food, and by procuring sleep, so as to allow the nervous system an opportunity of regaining its wasted powers.

The local treatment should consist in examining the wound for foreign bodies, and removing them, if possible, as they are frequently the exciting cause of nervous irritation, under the presumption that unless the local cause be removed we can expect but little abatement of the general tetanic excitement. Should

no foreign body be found, if it be possible, an incision should be made on the cardiac side of the wound, so as to divide the nerves implicated, and paralyze their sensibility. The powerful acids and the actual cautery have been recommended for the similar purpose of destroying the excited nerves at the seat of injury. Although they may be at times useful, I have seen fatal tetanus produced from ulcers under the cauterizing treatment; and I have recently lost a case, after amputation of the leg, from gunshot fracture of the tibia, in which mortification had attacked the entire stump. In this instance, after arresting the sloughing by the liberal use of fuming nitric acid, and succeeding in establishing a well defined line of demarcation, tetanic symptoms appeared and destroyed the patient in thirty-six hours. A solution of morphine, atropine, aconite, or kindred preparations, may be instilled into the wound, for their sedative action, and the water dressing, medicated with these remedies, continued.

If it be a small member wounded, such as a finger or toe, an early amputation may stop the spasm by removing the irritating cause, and, therefore, should be tried in all cases. This amputation should be performed irrespective of the local appearances of the wound, and even if it be nearly cicatrized. Should the injured extremity be in a sloughy state, so as to render its recovery doubtful, amputation should be performed at any stage of the disease. When tetanus supervenes upon an amputation, the surgeon would be justified in performing a second amputation upon the early establishment of the symptoms, as good results might follow such a course.

The constitutional treatment will have for its object the removal of all those general and local causes which may keep up excitement. *We should constantly bear in*

mind that tetanus is an affection of debility, and that the violence of the spasmodic paroxysm gives a *false* appearance of strength to the patient, while the principal source of danger and death is from exhaustion, induced by the excessive energy of the muscular movements, and the consequent want of rest.

In hospital practice, remove the patient at once to a small room or tent, where he will be alone with his single attendant. As the bowels are always constipated and loaded with offensive fœcal collections, which might assist in sustaining the excitement of the nervous system, they should be at once emptied by large doses of calomel, with gamboge, aloes, or podophyllum. When a difficulty is found in administering these, from the locked condition of the jaw, two or three drops of croton oil can be placed within the teeth, which, mingling with the saliva, will be swallowed. Three or four times the ordinary dose will be required to relieve the torpid bowels. The patient should then be kept perfectly quiet—if possible, by himself, as the stirring about of persons, noises, draughts, etc., excite sudden and repeated paroxysms of spasm. Ice bladders, blisters, or chloroform applications, may be made to the upper portion of the spine to allay, if possible, the irritation of this nervous centre.

Although opium is universally administered as an internal sedative, its good effects are not often obtained even when given in large doses. It is believed that it remains unabsorbed in the stomach, and therefore exhibits no action. The same of conium, hyoscyamus, and the entire class of sedatives, when given in the form of pill or extract. Unless medicines are given dissolved, they are not likely to be absorbed, or they are taken up so slowly that their good effects are not perceived.

Recently, in two cases of traumatic tetanus, I have tried the endermic administration of morphine in one-third grain doses, dissolved in a few drops of water, and injected by means of a Wood's syringe. In a few minutes the effect of the remedy was decided, but it was not persistent. By its use partial relaxation of the jaws could always be effected, so that the taking of nourishment was much facilitated; sleep could also be induced. It is by far the preferable mode of using opium, as its effects can be speedily and with certainty obtained. In one case, in which I injected one-tenth of a grain of atropine under the skin of the arm, the effect upon the pulse was so immediate that, in five minutes, it had increased from eighty to one hundred and fifty beats. It rapidly affected the salivary and mucous glands of the mouth—diminishing their secretions, without, however, producing dilatation of the pupils or causing relaxation of the muscles. As no beneficial effect followed the atropine injection, morphine had to be used, when relaxation to a certain extent was immediately obtained.

The liberal use of belladonna has been recommended, and, from its great utility in relieving congestions of the lower portion of the spinal cord, we might naturally infer similar good effects upon the medulla oblongata. The tincture of cannabis indica has been highly extolled. Some cases have recovered under its use, but a very much larger number have died in spite of its administration. The tinctures of veratrum viridis and gelseminum sempervirens are also favorite remedies with some, who speak of them as valuable means for calming the excited action of the heart and relaxing the stiffened muscles. Stimulating and nourishing fluids must be liberally administered at regular intervals, and, notwithstanding the difficulty in

swallowing, *the nurse should insist* upon their being taken. Many a fatal case can be laid to the charge of carelessness in the attendance, where the wishes of the patient are permitted to regulate the nurse's duties. Beef tea, eggs, milk, custards, eggnog, and similar articles of concentrated fluid nourishment, with wine, brandy, or whiskey, *must be frequently poured down the throat of the unwilling patient;* and if the mouth can not be sufficiently opened, the inhalation of chloroform, or the endermic use of morphine, should be freely used to effect it. I have seen excellent results from either of these relaxing agents. I have found porter an excellent tonic in such cases, as it combines both sedative, nourishing, and stimulating or supporting properties. The amount of stimulus to be administered must not be measured by the health standard, as I do not believe that intoxication can be induced while the system is laboring under tetanus. I believe that if inebriation could be brought about it would mark, in many cases, the commencement of convalescence. Under the frequent inhalation of chloroform the spasms can often be kept under control.

By pursuing the above course of keeping the patient quiet, using nervous sedatives, *with forced nourishment*, giving stimulus freely, and relieving the loaded intestines by croton oil, I have had the good fortune of saving three tetanic patients out of six cases which have come under my personal observation. As the three first cases which I treated were all restored to health, although they were very severe cases of traumatic tetanus, I imagined that I had found a successful mode of treating this dreadful disease, and published the same in the Charleston Medical Journal for 1857. Since that time I have had three cases under observation and lost them all, notwithstanding the same course was pursued as in the successful cases.

When the patient is able, constant smoking of strong cigars may be useful in quieting the excited nervous system. The impression among many observing surgeons is, that the patient is destroyed by exhaustion—called by some starvation. It is known that if the patient can be kept alive to the sixth day after the attack, there is a likelihood of his recovery, and that by the tenth day he may even be considered convalescent. If the debilitating effects of the disease can be counteracted by the free administration of very nutritious food, such as brandy, eggs, etc., many surgeons believe that the nervous irritation will wear itself out. It is based upon this belief, and the known failures attending the spoliative plan of treatment, that the above plan is urged.

Woorara poison has been recommended as an antidote, from its known powerful sedative nervous action, and its marked influence in counteracting the effects of strychnia. When poisonous doses of these substances are given conjointly, no poisonous effects are observed. The striking similarity between the spasms produced by strychnine and those of lockjaw suggested the use of woorara in this latter disease. As experiments proved it efficacious in the tetanus of animals, its field of usefulness was enlarged to the human subject, and several cases of its successful administration in chronic tetanus are reported. It was first used by inoculation; now it is given in the form of a mixture: ten grains of the woorara to a six-ounce mixture—a tablespoonful every half hour until perfect relaxation is produced. Should poisonous effects, with death-like symptoms, show themselves from an overdose, artificial respiration will support life and sustain the action of the heart until the poison is eliminated from the circulation by the kidneys. The

rationale of the remedy is to keep the spasms from killing the patient by their violence, until the morbid state calling them into play has exhausted itself.

From the known influence of quinine in diminishing the pulse, and its tendency to mitigate spasms, many consider it a useful drug in tetanus, and speak of it as a remedy well worthy of trial. Cures have been effected under its liberal use.

An expression which we frequently hear from a certain class of surgeons is: "That the wounded under their charge were threatened with tetanus, but the disease was kept off by judicious and timely treatment." The community take up the refrain in resounding the praises of their skilful attendants. Although we have had large experience in the treatment of wounds, we are still at a loss to understand the above expression. We do not believe that tetanus ever idly threatens, or that there is any symptoms by which we can be led to suspect the probable occurrence of the disease. When our suspicions are aroused tetanus has already, by unmistakable signs, laid its iron hand upon its victim, and can not, by any treatment which we may institute, be suddenly checked in its well known progressive march. We do not know of any abortive treatment for tetanus.

Periodic Pains.—Another sequela of gunshot wounds is more or less *permanent or periodic pain* in the injured limb, connected or not with paralysis of certain muscles—the nervous supply to which has been impaired or destroyed by the ball in its passage. When a nerve has been completely divided, permanent paralysis of the part supplied by it, and atrophy of the muscles, ensue—the limb gradually dwindling, if the muscles, indirectly destroyed, be important to the

common movements of the extremity. A bruising of the nerves, without division, is also followed by a paralysis more or less persistent, which time, however, and stimulating embrocations, will, to a certain extent, remedy.

In sabre wounds, in which the nerve is neatly divided and the tissues not displaced, the wound heals usually throughout its entire extent without suppuration, and sensibility and voluntary motion may slowly return. Both experiments upon animals and experience in man show that a reunion of the ends of the nerves may be effected when divided by a sharp cutting instrument, and nervous action restored to its former integrity.

When nerves are pricked, or in any other way injured without complete division, very severe neuralgic pains, with spasmodic action of the muscles of the limb, may be occasioned. These pains, which are often paroxysmal in their character, extend up and down the injured limb, and, as in cases reported by Guthrie, have, with irregular intermissions, annoyed the patient for years. In one case, although the severity of the symptoms subsided after six or seven years, annoyance was, at times, experienced forty years after the injury had been received. A coldness of the parts supplied by the injured nerve is not an uncommon effect, and is more or less persistent. Sudden changes in temperature, cold weather, or mental excitement, are among the exciting causes of such attacks.

The pains referred to are not such as are occasioned by the presence of foreign bodies—as a ball making injurious pressure upon a nerve at some portion of its course—but are apparently caused by an irritation of the nerve trunk, extending a sympathetic irritation through all branches distributed from the

nerve. From this cause, induced by a gunshot injury in the groin, I have seen irregular periodic pains, of great intensity, radiating from the groin and extending throughout the entire limb. In one case, although the wound had healed up readily, still. at the end of two years, the periodic pains, in severe paroxysms, persisted, notwithstanding the most varied treatment. An after-pain, which nearly all those wounded in the inferior extremity experience, and which is more or less persistent, accompanies a simple flesh wound.

When a ball traverses a limb, its penetration is effected by a combined movement which separates, divides, and destroys the tissues, all of these effects being more or less present in by far the majority of cases. These effects are very evident in the skin, which, in certain cases, appears as if its fibres had been divided; at other times, its fibres have evidently been torn, while, in the majority of cases, there is an actual destruction of skin. The perforated cellular tissue presents a canal with contused walls, that form in the centre of the canal corresponding with the axis of the ball, being destroyed and soon mortifying. The fibrous tissues may meet with a loss of substance, but usually present an irregular tearing, amounting, sometimes, to a split or separation of the fibres, to give passage to the projectile. The muscular tissues yield readily to the ball, which, by dividing and tearing, forms a canal, the diameter of which will depend upon the degree of tension of the muscles. If relaxed when traversed by the ball, the subsequent contraction of the fibre will give the appearance of much greater loss of substance than if the muscle were in tension, when its relaxation would elongate the fibre and tend to close the canal. As all the muscles of the limb are never in the same condition of tension or relaxation, a ball, in perforat-

ing, would find them in various stages of contraction, which would result in an irregular canal; at points so constricted as to have its continuity nearly interrupted, at other points widely dilated. In the healing of a wound, the first effort of nature is so to arrange the various tissues involved in the track of a ball as to bring like tissues in contact, and then keep them at rest until perfect union can be obtained. This is effected by means of plastic lymph, which, as a natural glue, is poured out freely among all the tissues.

When a ball perforates the limb and suppuration is established, the wound, in healing, forms adhesions to contiguous tissues, all of which, through the entire thickness of the limb traversed by the ball, are more or less matted together, the nerves being more or less squeezed by this excessive effusion of solid matter. The object of this free, plastic, interstitial deposit is to prevent retraction or displacement in the injured tissues, and enable nature to secrete her remodelling material upon a firm basis, and, by degrees, reunite the separated parts of similar structures.

After cicatrization there is a large amount of absorption of fibrinous adhesions necessary before the limb can regain its former movements and the muscles of the extremity play freely within their cellular envelope without disturbing contiguous structures. Until this absorption liberates the respective tissues, every action of a muscle involved in the wound must draw upon adherent and hypersensitive nerves, which, in turn, produces pain. It is on this account that a very large number of wounded, for months after their flesh wounds have completely cicatrized, suffer more or less severely whenever they attempt to use their injured limbs, and are only at ease when at rest.

In the latter class of cases, which are those con-

stantly met with in hospital practice, the indications for treatment are sufficiently obvious. Promote the rapid absorption of the effused lymph and liberate the nerves from the traction, while at the same time the irritation or increased sensitiveness of the nerve is mitigated, and the pain complained of will gradually disappear. The best means of meeting these indications are in the free use of stimulating narcotic embrocations. Any combination from the many articles of the materia medica, of stimulating and narcotic, or anæsthetic ingredients, would, in most cases, give the desired relief. An excellent and very efficient liniment for rubbing such a painful limb could be made by dissolving two ounces of any of the essential oils of the supply table and one ounce of chloroform in five ounces of alcohol—frictions with this liniment to be made on the limb twice daily. Camphorated soap liniment, containing laudanum, forms also a highly useful application. Each surgeon will, however, be guided by his own experience in combining ingredients for the relief of this class of cases. The internal use of quinine, aconite, hyoscyamus, belladonna, or, more especially, opium, will blunt sensibility, and will be required, during the course of treatment, as constitutional remedies.

In the treatment of every case, if possible, the patient should obtain sleep at night, and, with this object in view, opium, in some form, is constantly administered at bedtime.

The endermic use of morphine in one-fourth grain doses, or aconitine, one-sixteenth of a grain, dissolved in two or three drops of water, has given immediate relief when all other anodynes, administered in large doses, have failed to mitigate the pain. I place great confidence in the endermic use of morphine, as I have

never injected it without obtaining prompt and decided relief. In some instances a permanent cure has followed the first injection. Great reliance will hereafter be placed upon this new method of treatment. In some cases the persistent pain is found to depend upon a diseased condition, with subsequent enlargement of the nerve at the seat of injury. As, in such cases, the treatment recommended above will only give temporary relief, a complete division of the nerve at fault has been recommended and practiced with some good results. But as we have already referred to the fact that a nerve, divided with a sharp instrument, soon becomes reunited, and the pain, in many cases, returning when union is perfected, it has been suggested, as a more effective operation, to cut down upon the neuroma or nerve tumor, and remove all the enlarged portion. In simple flesh wounds this proceeding is very rarely called for—time, with stimulating anodyne embrocations, being usually sufficient to effect a permanent cure.

CHAPTER VIII.

TREATMENT OF WOUNDS OF THE DIFFERENT PARTS OF THE BODY, OR TOPICAL SURGERY—WOUNDS OF THE HEAD—CONCUSSION; ITS CHARACTERS AND TREATMENT—COMPRESSION: ITS SYMPTOMS—VARIETY OF WOUNDS OF THE HEAD; THEIR PROGNOSTIC VALUE—SIMPLE WOUND OF THE SCALP; TREATMENT—FRACTURE WITHOUT DEPRESSION; COURSE TO BE PURSUED WHEN INFLAMMATION OF THE BRAIN THREATENS—FRACTURE, WITH DEPRESSION, TO BE TREATED WITHOUT AN OPERATION—TREPHINING VERY RARELY CALLED FOR—COMPOUND FRACTURE, WITH DEPRESSION AND COMPRESSION; TREPHINING EVEN HERE OF DOUBTFUL PROPRIETY—PERFORATING WOUNDS OF THE CRANIUM COMPLICATED WITH FOREIGN BODIES.

Wounds of the head, when received in battle, require a special treatment, which can not be engrossed in the routine practice for wounds. Owing to the proximity of the brain and membranes, and the facility with which shocks or direct injury can be transmitted through the protective envelopes, injuries of the head possess a peculiar significance. All wounds of the head are more or less serious, as the surgeon can never know in advance whether the brain be injured, and what amount of irritation or inflammation will ensue upon such an occurrence. Hence the necessity of caution in prognosis and treatment, which the experienced surgeon will always exhibit, however trivial the wound may appear.

Injuries of the head would divide themselves into those produced from shot, small fragments of shell, or from a bayonet thrust—those from large portions of shell, or from clubbed musket—and those caused by the blow of a sabre. Wounds are found of every grade

of intensity, from a simple scratch to extensive destruction of the soft and hard parts, with or without those phenomena recognized as concussion and compression. As these terms will be continually referred to in speaking of the treatment of head injuries, we will, in brief, define the meaning which the surgeon attaches to them.

Concussion, or stunning, appears to be a shock to the brain, by which its substance is more or less shaken, with interference of its circulation, and often injury to its structure, and with suspension of its functions for a certain period.

Immediately as an injury upon the head has been received, if at all severe, the patient is knocked senseless. He lies perfectly insensible, motionless, and all but pulseless. His face and surface becomes pale and cool; the breathing, although feeble, is regular and easily perceived; the pupils irregularly contracted or dilated; sphincters are relaxed, in common with the entire voluntary muscular system, so that the contents of the bladder and bowels often escape involuntarily. After continuing in this condition for a few minutes, hours, or days, he gradually recovers consciousness. The heart first regains its accustomed action, the pulse gradually undergoes development, and the skin becomes warmer. At this period vomiting usually comes on, which arouses the action of the heart. This organ, under the excitement of emesis, drives blood to the brain, and with this free supply of stimulus to the general controlling organ, the patient rapidly rallies.

This is the common picture of concussion as seen in surgical practice, and the combination of its symptoms will be more familiarly recognized as those simulating ordinary fainting or syncope. The extremes

would be those cases in which the patient staggers, but, after supporting himself for an instant against some house, fence, or tree, recovers himself, and without further annoyance continues his employment; or those in which the patient is picked up apparently dead, with relaxed muscles, pale surface, glassy eyes, scarcely perceptible pulse, and very feeble and irregular respiration. The death-like appearance in such cases of severe concussion becomes more and more confirmed, the breathing gradually ceases, and the pulse imperceptibly flitters away, without any sign of consciousness from the moment of injury.

In fatal cases, where concussion had been present, the brain has been found more or less injured, and so highly congested as to exhibit a dusky hue. Fissures have been found in its substance, or extravasations of blood in numerous or concentrated spots. In certain instances the brain has apparently shrunk from the excessive shaking or vibrations to which it has been subjected, so that it no longer fills the cavity of the skull. In some fatal cases, where the brain had been fissured, the commotion among its particles had apparently at once annihilated its functions, so that the heart's action had instantly ceased, and no blood had been driven to the mangled brain to be extravasated into its substance. In some cases of nearly instantaneous death from concussion or stunning, the brain, upon examination, appeared in every respect healthy, the lesion, in its substance, not being perceptible to the eye. On the other hand, in cases of perfect recovery after concussion, where the patient had lived for a considerable period (weeks or months) in the full enjoyment of all his faculties, and had died from some disease totally foreign to the former head injury, extensive lesions have been found in the brain, and traces

of large and extended extravasations of blood, which covered the hemispheres, as well as traces of blood clots in the cerebral substance. The irritable condition of the brain in which the patient is often left, after concussion of limited duration, with the impairment of memory, or of some one of the special senses, or even partial paralysis of the limbs, would be physiological proof of cerebral injury. Although its symptoms are usually transient, we may, doubtless, consider it a contusion or interstitial laceration of brain substance.

As the appearances of a man stunned by a blow are very alarming to those not familiar with the march of such lesions, those interested in the injured man are always clamorous for active interference, and it is with difficulty that the surgeon can free himself from the urgent solicitations of friends who believe that, unless prompt means are used, the accident must terminate fatally. The surgeon, under such circumstances, requires all of his presence of mind to resist the importunities of those who are urgent with their advice, and with firmness should strictly pursue the non-interference plan of treatment.

The course which rational surgery now recommends is to lay the patient horizontally, with his head, perhaps, a little lower than his body, so that the brain may have the benefit of gravitation to assist in its supply of blood. He is wrapped in warm blankets, bottles containing hot water are placed around his body, and dry frictions, with or without mustard, used upon the extremities to excite the re-establishment of the circulation; but beyond this the surgeon should not interfere. *In an ordinary case of concussion, the safest practice consists in doing as little as possible. The indiscriminate use of stimuli on the one hand, or*

bloodletting on the other, are to be especially and studiously avoided.

Only a few years since bleeding was the practice in stunning, and the amount of mischief done by this universal mania for bloodletting was often irreparable. We might as well bleed in a fainting fit and expect good results. We find, as in syncope, that the heart scarcely pulsates; and so little blood is driven to the surface that it is pale and cold. A similar condition exists in the brain, where so little blood circulates that, from want of this natural stimulus, its functions are temporarily suspended. Were it possible to draw away much blood from this organ, the cessation of the nervous functions would become permanent.

Modern surgery, in studying the natural history of diseases and injuries, perceives now, what it should long since have recognized, that nature, in her desire to harbor the circulating fluid, tries to put a safeguard against the rashness of surgeons, by shutting up the bulk of this living, precious fluid in the inner recesses of the body, where it can not be easily despoiled. On account of this change in practice, we now seldom hear of deaths from concussion, which was comparatively of common occurrence a few years back.

As regards stimulation, we must also desist as long as it is possible, and give it with a most cautious, sparing hand, only when its administration becomes compulsory. Remember that the degree and duration of shock depends upon the extent of injury which the brain has received, and that nature, always the most skilful physician, accepts this concussion as a safeguard to prevent further mischief. How are we to know that the brain has not sustained severe injury, extensive bruising or laceration, with more or

less extensive division of blood-vessels; and that this extreme depression of the system, with consecutive control of the heart's action, is not especially indicated to prevent hemorrhage within the brain substance, and rapid death from compression induced by extravasated blood? We know this, that after severe injury to the brain, when, through officious meddling and the free use of brandy, the symptoms of concussion early disappear, violent reaction is induced, and internal hemorrhage or violent inflammation soon shows itself; and that, for the doubtful gratification of seeing the patient rapidly revive, we have the mortification of seeing him as rapidly destroyed.

Cases of concussion, absolutely requiring stimulants, are but seldom met with in practice. Even when of a very severe form, all that is necessary, in the vast majority of cases, is to apply warmth to the surface, and to watch carefully the pulse.

Should it so happen—but this occurs rarely—that the patient is manifestly in danger of sinking from depression of the circulation, then stimulants must be resorted to. *As long as the pulse does not lose its strength under concussion of the brain, although the insensibility last for hours or even days, desist from active interference.* After-trouble will be avoided by allowing nature to take its own course unmolested. When, from the great and long-continued depression, stimuli are called for to prevent threatening dissolution, their effects should be carefully watched, and, as soon as reaction is apparent, with an improving pulse, at once desist from the further use of stimuli. As is the state of depression, so will be the state of reaction. When the depression is extreme, the reaction will in time be correspondingly excessive, and especially so if stimuli have been freely administered.

When the patient has recovered from the state of insensibility, he should be kept perfectly quiet; excitement of every kind should be carefully avoided. The diet should be simple, the head kept cool, and any tendency to constipation corrected. Beyond this no treatment is required until expressly called for by excessive reaction, accompanied with symptoms of congestion or inflammation of the brain. The precautionary bleeding, with repeated doses of calomel, to ward off symptoms which, in far the majority of cases, would not have occurred, was the routine practice of the old school, and can not be too severely condemned. The complications which might arise in injuries of the head, after more or less serious concussion, will be hereafter considered.

COMPRESSION.—Concussion is always simultaneous with the blow, and gradually decreases, if death does not carry off the patient at an early period. *Compression*, the condition with which it is often allied, usually comes on some little time after the reception of injury, although it may appear either at the moment, or may not show itself for days, or even weeks, after the injury. The name explains the lesion; compression, referring to pressure upon the brain, made either by a portion of the skull or some foreign body driven into or upon the cerebral mass; or by an escape of blood from some torn vessel, which, by forcing itself into the unyielding skull, compresses its contents; or by an effusion of lymph or formation of pus, which inflammation causes to be deposited within the cavity of the skull.

The symptoms by which this condition would be recognized are as follows: The patient lies in a state of coma, stupor, or lethargy—one side of the body

being paralyzed more or less completely, both as regards motion and sensation. He is dull, drowsy, or even insensible; at times answers mutteringly when rudely shaken or loudly spoken to, but immediately afterward is again breathing slowly, heavily, and laboriously, as if in deep sleep. Should his face be examined, the lips and cheek on one side will often be found to flap during expiration, producing a blowing sound, as if smoke was being blown from the mouth in the act of smoking. There is paralysis of that side of the body opposite to the seat of injury, and, as a necessary consequence, the air forced from the lung in expiration puffs out that side of the face in which the muscles have lost tone. In attempts at speaking, for the same reason, the corner of the mouth is drawn over to the sound side. The countenance is usually pale, cold, and ghastly, although it may be flushed with a hot and perspiring skin; the eyelids, particularly of the paralyzed side, are partly or completely opened, with the pupils dilated and insensible to light; the pulse is slow, the heart acting under great oppression. There is usually constipation with torpity of the bowels, and as the sphincter muscle of the rectum is paralyzed, there exists usually involuntary discharges of the feces. From want of action in the bladder the urine is retained, and, unless drawn off, will decompose within the organ. If the urine is not drawn off with a catheter, the accumulation of fluid increases until the bladder is either ruptured, causing a poisonous infiltration into the contiguous tissues, or the blood becomes poisoned from the absorption of decomposing urine. These symptoms are not always equally marked—their extent depending upon the suddenness and degree of compression. Unless the causes of pressure be removed, the case usually

terminates fatally, although cases are not rare in which, after days of unconsciousness, reason has gradually been restored — the accompanying paralysis slowly disappearing.

Having now explained the two conditions of concussion and compression, which so commonly accompany severe wounds of the head, we are better prepared to study this special class of injuries.

The divisions which experience has proved of practical utility, are:

1. Injury to the soft parts alone, uncomplicated with injury to skull or brain.

2. Wound of soft parts, with simple fracture of the skull.

3. Wound with depressed fracture of the skull, but without symptoms of compression.

4. Compound depressed fracture of the skull, with symptoms of compression of the brain.

5 Perforating wounds of the skull, complicated with foreign bodies in the brain.

From the peculiar formation of the skull and the resistance which it offers to blows, unless a shot strikes it fairly at right angles, it does not perforate; but whether it be a grape, musket, or pistol ball, it flies off at a tangent, and running beneath the skin upward, downward, or laterally, escapes. The head has been struck obliquely with even a round shot without serious injury.

The patient may, or may not, be knocked down by the blow; severe pain is felt, and a puffing up of the part instantly follows. When the hair is removed, although there may be no discoloration of the skin, there is abundant evidence of subcutaneous lesion, which will soon develop inflammation and suppuration in the scalp. The severity of the blow upon the

head may have knocked the patient senseless, and in this condition he is found by the litter-carriers.

The transportation of head injuries requires great care, and the best transports should be devoted to this service. When the patient arrives at the field infirmary, where he should be kept for treatment and not sent off to a general hospital, he is laid down, with the head low, until he recovers himself. The restoration is left to nature; cold water may be dashed into the face, but all stimulation should be avoided unless the pulse is found to flag, when a little brandy may be cautiously given. The surgeon takes advantage of the insensibility of the patient, shaves the head at the point of injury, and gives the wound a thorough examination. *Using always the finger as a probe*, he explores the track of the ball, examining the condition of the skull to find out whether it has been exposed, and whether, simply grooved by the ball, the injury involving the outer tablet only, or whether the skull is broken through. When reaction has taken place and the patient is restored to consciousness, should the wound have been a simple one of the soft parts, the cold water dressing is all that will be required, and should be applied according to general principles. The thin, wet compress, covered with an oiled or waxed cloth, should cover the wound and head for some distance around the injury; and instead of tying these in place by the roll of bandage, the better plan for keeping on the dressing is to adopt the head-net of the Prussian medical service. It is a round piece of coarse netting, made of cotton yarn; a string, from either side, ties under the chin to keep the dressing on, and a drawing-string running around the net, like a purse-string, attaches it securely to the head around the temples. This is an admirable

dressing for all head injuries, which require light, cool, and efficient applications.

A very useful, although not so elegant a bandage, is made from a piece of soft cloth, twelve to fourteen inches wide, and from twenty-five to thirty inches long. This is slit, from each end, into three unequal parts, leaving a wide bandage between two narrow ones—the three slits, of either end, being interrupted in the middle of the bandage by a bridge, four inches wide, where the cloth has not been torn. In its application, place the centre of this three-tailed bandage over the crown of the head, encircling the temples from behind forward by the two posterior ends, and in the same manner from before backward by the two anterior ends of small bandage. The centre ends can either be tied under the chin or can be carried back over the head. If the lateral bands secure it sufficiently, the centre ends may be cut off on a level with the temples, and pinned to the lateral bands. When firmly secured around the head, the whole completes a "*bonet de nuit*," which will retain securely any applications required in the treatment of head injuries.

Should the soft parts have been much bruised, the ice bladder, or continuous application of cold water, may be required to keep down excessive suppuration. To prevent mischief, and to avoid those complications caused by irritation or inflammation of the brain, all injuries of the head demand rest and quiet, avoidance of stimulants, and abstemious diet. By adopting this course in uncomplicated wounds, whether gunshot or sabre, a speedy cure is usually obtained.

When free hemorrhage occurs in connection with wounds of the head, and evidently from an artery of the scalp, it is seldom necessary to apply a ligature,

as pressure exercised upon the skull will readily check the bleeding. Effusions of blood under the skin should not be instrumentally interfered with; incisions are not required. If the effusions are allowed to remain excluded from air, the cold water dressing, rendered stimulating by the addition of tincture of arnica, will cause their rapid absorption. If the skin is punctured and air admitted, suppuration will surely ensue. Should suppuration occur, and especially erysipelatous inflammation, which so frequently accompanies injuries of the scalp, as soon as pus can be clearly detected, let it out by a small incision. If this operation be not attended to at the proper time, the pent-up pus will separate the periosteum from the skull and cause, perhaps, a necrosis of the bones. Chronic disease of the skull is often induced by a disregard of the foregoing rule. When suppuration has been well established, an oiled cloth is substituted for water dressings by many surgeons, although the growing disposition is to continue the wet cloth, to be renewed as often as cleanliness requires, until cicatrization is completed.

When the skull has been fractured by a ball, sabre blow, or fragment of shell, the treatment should in no material respect differ from the course pursued in simple scalp wounds. A simple or compound fracture of the skull, uncomplicated with injury to the brain or its meninges, should be managed according to the ordinary principles of surgery—remembering always, however, that the brain is in near proximity, and may have been injured, although no symptoms are present for detecting such a lesion. If the patient is insensible, we adopt the means already recommended for removing shock; viz: place the body in a horizontal posture, and leave the case pretty much to nature—avoiding everything tending to internal stimulation. While

insensible, we examine the wound thoroughly, using the finger as a probe; and if any loose spiculæ of bone or foreign body be felt quite free in the wound and unconnected with the soft parts, they should be removed. If attached, they should be left to escape after suppuration is established. On rare occasions a ball may be found embedded in the diploë without having broken, to any extent, the inner tablet. If firmly embedded, the easiest mode of removal, with least damage to the skull, is to cut through the outer tablet with the trephine.

Fractures caused by balls are usually distinctly limited to the portion struck, and seldom ramify as do fractures from diffused blows, such as those from large fragments of shell, etc. It is this concentration of the force within a small compass which renders gunshot injuries of the head so serious.

When we are satisfied, from a careful examination of the condition of the bones, that they remain in their normal position without depression, no instrumental interference should be attempted. As soon as the patient has revived, and the symptoms of concussion or shock have passed off, the cold water or ice treatment should be at once instituted. Should there have been but little shock from the injury, the head should be shaved and wet applications should be at once applied. This treatment might be commenced even on the battle-field. Such cases are always injuriously affected by a long, tedious transportation, and therefore are included among those cases which should be treated upon the battle-field, or at some farmhouse in the immediate vicinity of the field infirmary.

When the patient is put to bed (which should be as soon as possible after reaction has taken place, for early treatment is, at this stage, all-important) his

head and shoulders should be elevated, and quiet, with absolute rest, should be enjoined. The room should be kept dark, and all stimuli, including light and noise, should be, if possible, avoided. The bowels should be freely opened by a saline, mercurial, or aloetic cathartic, and for a few days abstemious diet prescribed. These precautions are necessary to prevent irritation of the brain, with subsequent congestion, inflammation, and effusion. If the patient appears irritable and peevish, *without much heat of head or fulness of pulse*, give opium to quiet him.

The case should be watched with care, and if symptoms of congestion of the brain threaten, with injection of the face, red eyes, hot skin, forcible throbbing of the carotids, increasing headache, with an early tendency to delirium, the patient might be at once bled. The head should be shaved, and an ice bladder or cloths wet with cold water, and frequently renewed, be assiduously applied over the entire scalp. The intestines should be freely acted upon, so as to obtain the revulsive effect of the purgative upon the brain, and, for a similar reason, mustard should be applied to the legs and thighs. Should relief not be promptly obtained, leeches or cups might be applied to the temple or the scalp behind the ears, or a large blister put upon the back of the neck, extending down between the shoulders. Calomel was formerly the universal prescription for threatening cerebral inflammation. Salivation was induced as early as possible, and when the system was brought under its influence the patient was considered comparatively safe. In modern surgery calomel has lost its high position, and the dependence upon its salivating powers is annually diminishing. Many still use it, but not with the confidence of former times.

Should this threatened inflammation not subside under this course of treatment, but, after a period of high febrile excitement, the delirium becomes merged into stupor, with noisy breathing, dilated pupils, slow, labored pulse, relaxed sphincters, and paralysis, the case indicates compression from effusions within or upon the brain, and chances for life become very doubtful. Perhaps a thick layer of lymph may have formed upon the cerebral surface, or a quantity of serous fluid collected in the ventricles, or a circumscribed or diffused abscess may have collected in the substance or upon the surface of the brain. This lymphy effusion or collection of pus sometimes covers the entire surface of one or both hemispheres. In such cases the arachnoidal membrane appears to be the one chiefly inflamed. It is thickened, semi-opaque, reddened in patches, and adherent to the brain surface as well as to the reflected lining of the dura mater by bands of newly deposited lymph. The pia mater and brain substance is also highly injected.

If, with the occurrence of these symptoms, the patient be seized with chills, the scalp wound becoming dry and the tissues puffy, or a collection forms under the periosteum, lifting this membrane from the bones, which, when exposed, appear dry and yellow, it would indicate, in many instances, a circumscribed collection of pus within the skull. These symptoms might be, but very rarely are, relieved by the use of the trephine, and, as a general rule, the case progresses steadily to a fatal termination. Unless an external abscess, with the characteristic puffy scalp, defines the collection of effusions within, the trephine should not be used, as there would be little probability of perforating the skull in the vicinity of the collection. It often happens, after trephining, that these supposed

collections have not been found, and it is only after the irritating effects of the operation that the secretion of pus has been established. When air is freely admitted to the meninges suppuration is highly probable, while, without the operation, the effusions of blood, lymph, etc., are known, in many instances, to have been absorbed—the patient recovering after remaining insensible, in one case, as long as twenty-one days.

Cole, in his Military Surgery, mentions cases of fracture of the skull from ball, without the skin being torn. Such cases are very difficult of diagnosis. Unless the bones are much displaced, as they were in one of his cases, the condition would scarcely be suspected. Such injuries must be treated under the antiphlogistic expectant plan. *Await symptoms of compression before active surgical interference is instituted, and we will never regret it.*

There are a series of cases in which injury to the skull is complicated with internal bleeding. The insensibility which seized the patient at the moment of injury will pass off, and the consciousness will be regained, but only for a time. The patient, after a longer or shorter interval, feels heavy and dull, and indisposed to exertion; until, finally, a strong disposition to sleep comes over him, which, deepening into coma, ends in all the symptoms of well marked compression. This is an instance in which the surgeons of twenty years since would have trephined, as the only chance of saving the patient; and should the collection of blood not have been found under the first perforation in the skull a second, third, etc., would have been made in search of the extravasated fluid until, in some recorded cases of a former surgery, the head had literally been sieved by twenty orifices.

Now we would lay down an equally broad rule,

that his chances for recovery are increased by avoiding the trephine. Pursue a rigidly antiphlogistic course. Free venesection, when assisted by ice bladders to the entire scalp, will stop further loss of blood. Reduce the action of the heart by veratrum, gelseminum, or digitalis, and permit the effused blood to clot, so as to close the openings in the torn blood-vessels. Then, by free purgation, act upon the bowels, both for a derivative effect and to promote the absorption of the effusion. If you can stop the further escape of blood, that which has been effused will gradually be removed, and the symptoms of compression will as gradually pass off, after having continued, perhaps, for days, or even weeks. Trephine such a patient, and what certainty have we that the point where hemorrhage has taken place will be unmasked, or that the blood is still fluid and can be removed—both very improbable results. Blood-vessels may have given way at any other portion of the brain than at the portion corresponding to the point where the skull is injured. The recoil of the contents of the skull from the blow may have ruptured vessels diametrically opposite to the injured point. Autopsies not unusually reveal such conditions.

In gunshot wounds from musket-balls the fracture of the bones of the skull is usually circumscribed, and when situated over the course of a large meningeal vessel, and these symptoms of internal hemorrhage supervene, there will be a probability that the injured blood-vessel is in the immediate vicinity of the wound. Usually, in such cases, the hemorrhage would show itself by the escape of blood externally. Under such circumstances it would be necessary to remove the portions of broken bone, either by the trephine, saw, or forceps; and the bleeding vessel, if seen, should be se-

cured by ligation or by the pressure of a torsion forceps. These conditions, however, rarely exist, and the location of hemorrhage is exceedingly doubtful. The operation of trephining is always very serious *per se*, and is, in many instances, sufficient of itself to cause cerebral or meningeal inflammation, which will nearly always terminate fatally. The operation is often as serious as the condition for which it is used, and, although the patient might recover from either, he succumbs under the combination. Experience and autopsies have shown us many cases of extensive intra-cranial hemorrhage, which have been unaccompanied by symptoms denoting such an accident; and the evidences of such have only been found when the patient, recovering from his head injury, had, at some subsequent period, fallen a victim to a totally foreign disease. Had such a condition been suspected, and the surgeon used his instruments with the object of allowing the effused blood to escape, most probably an autopsy, at a much earlier day, would have revealed the condition.

The third variety of gunshot injury of the head, with depression of the skull, belongs to a more serious class of wounds. The complication is detected without difficulty by examining the depth of the wound with the finger, when the sinking of the bones is felt, the extent of injury defined, and the condition of the depressed portion, whether *en masse* or spiculated, determined. The depressed portion of bone, although usually accompanied with symptoms of compression or pressure upon the brain, may have no such complication. The mind may remain perfectly clear, and the patient enjoy the voluntary control of all of his limbs. In certain cases of depressed bone, however, there exists paralysis of the limbs on the opposite side

of the body to that side of the head injured. This class of fractures of the head are considered very dangerous, inasmuch as the depressed fragments of the skull—which usually has its inner tablet much more extensively broken and displaced than the outer—may have been driven through the membranes into the substance of the brain, and there establish such a train of inflammatory symptoms as will destroy life. A very large number, however, recover perfectly from such injuries.

In simple fractures of the skull, even with depression of the fragments, but without a wound of the soft parts, the rule to be followed is to avoid the use of instruments, and exclude air from coming in contact with the broken bones through an incision made by the surgeon. Even when symptoms of compression accompany the displacement, it is thought expedient, by many surgeons of large experience, not to operate. In gunshot fractures of the skull the case is somewhat different, as there is always a wound connected directly with the fracture. Still, as a rule, we must avoid meddling with the parts. If, upon examination, many spiculæ of bone are found detached from their connections, and lying loosely in the wound, they should be carefully removed. This is done as soon after the injury as possible, and often while the patient is suffering from compression. Should the symptoms of concussion have passed off, and no indications exist of injurious pressure upon the brain, nor of loose fragments of bone in the wound, surgeons of experience recommend that the case be treated in every respect as if no depressed fragments existed. In such cases, unless we can clearly determine that the bone is very much spiculated, and that sharp fragments are probably piercing the meninges, we should

avoid all instrumental interference, even to dilating the wound, for the purpose of facilitating a more accurate diagnosis.

A rule which can not be impressed upon us too early is, that we should never be anxious to see the symptoms of concussion rapidly disappear in such cases; *let nature abide her time;* watch the case, and see that the patient suffers no detriment. *Examine frequently the pulse, but not the head, and as long as it sustains itself, everything is working to the advantage of the wounded.* With a rapid reaction, torn blood-vessels may not have had time to become plugged up, and internal hemorrhage, which is always serious, might ensue. Lay the patient in a horizontal position, cover him with blankets, and, if required, use external warmth. Internal stimulation would not be required in the majority of cases. It is only when the pulse evidently flags that it should be used. As soon as the pulse indicates an improvement, we commence cold applications to the scalp, which should be continuously and assiduously applied. When inflammation of the meninges, which may make its appearance about the fifth day, threatens, revulsives, acting by derivation to the intestines, as recommended in the treatment of simple fractures, with ice or cold water to the head, are the remedies upon which most reliance is to be placed. When severe headache or exciting delirium is present, cold water may be frequently poured over the head in douches with decided benefit. Free purgation is not desirable, as the frequent change of position would be injurious to the patient. Should the integuments and pericranium inflame, with much swelling, pain, tension, and with febrile reaction, bring on the formation of pus, or if the wound does not give ready exit to the purulent

secretion, a free incision must be made to release the pent-up fluids.

W Surgeons are now becoming familar with the fact that considerable depression may exist in the external tablet of the skull without the internal having been fractured—the external layer being driven into and condensed within the diploe." Also, that both tablets may be depressed, compressing the brain, without causing harm at any subsequent period. Observation has multiplied these cases to such an extent as to modify the entire treatment of head injuries. Although the cranial cavity is filled with brain, its contents are continually undergoing changes, from the excessive vascularity of the brain substance, and also from the free communication which exists between the fluid, filling the ventricles and the venous plexi which abound in the brain. By diminishing the blood and water in the brain, accommodation can be made for the depressed bone.

As a general rule, in gunshot wounds of the skull, with depression of fragments, no remarkable symptoms exhibit themselves until there is a determination of blood to the head from reaction, brought on by mental or bodily excitement. Rational practice would lead us to combat the tendency to congestion by rest, quiet, cold, and revulsives, rather than by the trephine, which experience has shown to be unprofitable. Opium is now used with much greater freedom in the treatment of injuries of the head than formerly; and, when administered with discretion, will, to a certain extent, take the place of trephining. Whenever the patient is restless, sleepless, and irritable, with delirium, should the face not be red, nor head hot, opium, or some of its preparations, can be used with safety and benefit.

Those surgeons who are opposed to the use of instruments in cases of compound fracture of the skull have been led, by experience, to refrain from removing the spiculæ until suppuration is well established.

In gunshot wounds of the head this will be found the safest course to pursue, and is in opposition to the rule laid down in gunshot wounds of the extremities, where it was recommended to remove all loose portions of the bone.

When granulations commence to form, those portions of bone which can not be saved will gradually become detached, and will escape. A tendency to bleeding in the granulations of such a wound is an indication that the fragments of bone have become loose, and are ready to be removed. This symptom, which is a valuable one, must be noted.

The fourth variety of injury to the head, and by far the most serious, is that in which a compound fracture, with depressed fragments, is connected with symptoms of compression and paralysis. This is the only variety of complicated head wounds in which surgeons now consider instrumental interference justifiable; and even in this instance, although no doubt exists that, in some cases, immediate relief has followed the lifting of the depressed bone, the propriety of trephining, as a rule, is doubted by many army surgeons of large experience. The successful treatment of such injuries will depend more upon the condition of the brain and membranes than merely upon the depression. Should these be lacerated, or in any way injured, inflammation will probably show itself, sooner or later. The operation of trephining, under such circumstances, would increase the local irritation, expose the injured tissues to injurious atmospheric influences, and hasten on a violent, and usually fatal, inflammation.

If the brain and membranes be not injured, experience teaches that the brain will soon become accustomed to the pressure; and, although insensibility may continue for hours, days, or, as in many instances of ultimate recovery, for weeks, the symptoms of compression and paralysis will gradually pass off. By not using instruments, the surgeon has the satisfaction of knowing that he has not increased the local trouble by a serious operation. When the depressed bone is not raised, the removal of the symptoms of compression, being very gradual, excessive reaction is not likely to follow; and as no air has been admitted to the effusions beneath the skull, the probability of suppuration will be much diminished. When effusions have taken place, the depressed bone acts as a covering, excluding air, with its injurious chemical influences; and autopsies at some distant period show that fluids, uncontaminated by decomposition, can be absorbed. When the skull is opened, and the free admission of air is permitted, suppuration, with, perhaps, pyæmia, is prone to occur.

Stromyer, who is one of the highest authorities on gunshot wounds of the head, and who, as surgeon-in-chief of the Schleswig-Holstein army, had every facility for studying his favorite branch of surgery, gives us, as the result of his experience, observation, and study, that the trephine can be abandoned in military surgery. In a supplement to his work on Military Surgery, recently published, he states: "*That in military surgery trephining is never needed.* When the case is so severe as to require the trephine in gunshot wounds, the patient will die in spite of it." In the last two campaigns, in which he had charge of the army, he has not trephined. Loeffler, a distinguished surgeon in the Prussian service, who has published

one of the best books of instruction for military surgeons, after acknowledging Stromyer as the master in all relating to the treatment of gunshot wounds of the head, endorses his views in opposition to trephining.

McLeod gives the following as the Crimean experience: "As to the use of the trephine—the cases and time for its application—less difference of opinion, I believe, exists among the experienced army surgeons than among civilians; and I think the decided tendency among them is to endorse the modern 'treatment by expectancy,' and to avoid operating except in rare cases. In this, I believe, they judge wisely; for when we examine the question carefully, we find that there is not one single indication for having recourse to operations which can not, by the adduction of pertinent cases, be shown to be often fallacious." Hewett, in a series of lectures on injuries of the head, published in the Medical Times and Gazette for 1859, which form the most complete treatise extant on the subject, is equally adverse to the trephine. Guthrie, Cole, and Williamson, in their reports, equally confirm the dangers of the trephine, and the great fatality accompanying its use.

The entire records of the science may be searched in vain to find a duplicate series of successful cases to that reported by Stromyer. Of forty-one cases of fracture, with depression from gunshot wounds, in many of which it was probable that the brain and membranes were injured, only seven died—all the rest recovered. In only *one* case was there any operative interference, *although signs of secondary compression appeared in several.* The antiphlogistic treatment, carefully carried out, was alone adhered to.

No surgeon can doubt that the operation of trephining has cost many a man his life; and although many

cases have recovered after the operation, it is a question whether, in the majority of cases, more rapid recovery would not have been obtained without it.

When symptoms of compression, accompanied with paralysis, and, finally, stupor, ensue in the course of treatment, continue the steady, onward use of antiphlogistic remedies. At this juncture many surgeons recommend calomel pushed to salivation, which some state to be synonymous with salvation. There is, however, no unanimity on this head; the modern practice is to treat such cases without the use of mercury.

At this stage of the case, which is one of extreme gravity, a successful course of treatment can hardly be expected. Should the symptoms of compression have been preceded by one or more severe chills, with excitement of the pulse, pain in the head, divergence of the eyes, protrusion of the tongue to one side, a dull, pricking sensation in the arm and leg opposite to that wounded, we might feel assured that pus, or some effused fluid, has been thrown out upon the brain, and, usually, that the substance of this organ has become more or less softened. As such cases are exceedingly fatal, the operation of trephining is usually performed, hoping that the collection of pus may be found and discharged, and that, by the relief of pressure, the serious symptoms may be also removed. Very rare instances of such successes are upon record, but in by far the majority of cases the symptoms continue unabated, even when the abscess has been opened.

The following case is pertinent to the subject under discussion:

Private L. Shumpert, Company F, 20th regiment S. C. V., aged eighteen, was stunned by the explosion of a shell during the bombardment of Battery Wagner,

July 18, 1863 He soon revived, and was sent to a hospital in Charleston on the following day. Upon examination a small shell wound was found in the scalp behind the left ear, but was, apparently, of a very trivial character. He was transferred to a hospital in Columbia on the 23d of July, 1863. The external ear had been perforated by a small fragment of shell, and, in connection with sensitiveness of the scalp, there was contusion of the tissues behind the left ear. Under the usual cold water dressing the wound rapidly healed, the sensitiveness disappeared, and only a small orifice in the scalp behind the left ear remained open—all swelling having subsided.

Since his admission he had been considered a convalescent, and had associated freely with the inmates of the hospital. He was now nearly ready to return to his regiment, when, on the 30th, he complained of feeling his eyes filling with tears when spoken to, which was attributed to his anxiety to get home. On the 31st he complained of great weakness, left eye suffused, and orbicular muscles slightly paralyzed, with inability to turn his head to the left side.

August 1.—He had fever, pulse one hundred, tongue coated, bowels costive, spirits depressed. As these febrile symptoms continued, he was treated for continued fever. On the 7th he had a severe chill, which was repeated during the day, with tendency to sleep. When roused, he complains of pain in the back. The chills appeared again on the following day, with gradually increasing stupor. As he had, at no time, complained of his head, the presence of the wound was altogether overlooked. On the 9th a purulent discharge was noticed from the ear, which attracted suspicion to the head, and suggested the probability of an abscess upon the brain.

Coma being well established by the 10th, and a probe, passed into the small wound behind the ear, having come in contact with denuded bone, it was decided to dilate freely the wound, expose the bone, and, should any fracture and depression of fragments be found, to trephine. As the mastoid portion of the left temporal was found denuded, with a depressed fragment of skull at the junction of this bone with the occipital, the trephine was used, and several fragments of the inner table, which were found detached, were removed. The trephine had been applied directly over the lateral sinus, and the anterior edge of the orifice corresponded with the line of attachment of the tentorium cerebelli. No pus was found. No amelioration of symptoms followed the operation, and the patient died twelve hours after it.

An autopsy revealed a fracture of the skull, which had completely separated the squamous from the petrus portions of the left temporal bone, the fissure extending in front of the ear to the base of the skull. Inflammation had been excited in the membranes as well as in the substance of the brain at the base of the skull, and a large accumulation of fœtid pus, about four ounces, had collected in the arachnoidal cavity, and had so compressed the hemisphere of the brain that there was a space fully an inch in depth between the flattened hemisphere and the skull—the pus covering the entire surface of the hemisphere from the tentorium cerebelli to the falx cerebri. The base of the brain, corresponding with the broken bone, was softened, and of creamy consistency. Had the trephine been placed one quarter of an inch more anteriorly, it would have allowed the escape of pus, although the emptying of the abscess could not have saved life, as experience shows injuries to the base of the brain,

followed by inflammation and coma, to be always fatal. The case is of much interest in many respects, but more especially shows that an injury of the head, of the most serious character, may be inflicted without creating even a suspicion of its existence; and as this may frequently occur, it should teach us to consider all cases of head injury serious.

When balls penetrate or perforate the cranium, the detached pieces of bone are driven before the ball into the substance of the brain, leaving an orifice in the skull larger than the missile which made it. The resistance which the ball meets may change its course, and, glancing from the depressed fragment, it takes a different direction—burying itself in the brain at some distance from the piece of bone.

In by far the majority of cases death is instantaneous, or soon follows the receipt of this injury. In such cases it sometimes happens that the patient has survived the shock, and has been, to all appearances, recovering rapidly, when he is suddenly seized with coma, and rapidly dies. There are, nevertheless, a few exceptions to this rule, in which the patient, recovering from the shock and sequelæ, although he may have lost a quantity of brain substance, has carried the ball or other missile within his cranium for years. Eventually dying of some disease unconnected with the head, an autopsy has revealed the ball embedded in the brain, and surrounded by a mass of lymph. Of ninety-one cases of penetrating and perforating gunshot wounds of the head which were admitted into hospital in the Crimea, all, without exception, proved fatal.

When the openings are examined, it will be found that the hole made in the outer tablet is more or less smooth, while the orifice in the inner tablet is much

more extensively fractured, and usually much spiculated. This condition of the orifices is owing more to the direction of the blow than from any supposed brittleness in the inner tablet—for, should the ball traverse from within outward, the reversed condition is found. It would be folly to attempt the search after such foreign bodies for the purpose of removing them, as such a piece of meddlesome surgery would, in by far the majority of cases, ensure a fatal issue, whatever hope of recovery might have been previously entertained.*

Cole, in his Indian Reports, mentions "That there are many soldiers now doing duty in our ranks for whom (having been wounded in their heads during the late war) the medical officers had not the smallest hope; and every military surgeon, who has had much practice in the field, has learned not to despair so long as life remains." The thorough probing of such wounds with a metallic probe, to satisfy the curiosity of a surgeon, would soon have destroyed all hope, with the life of the patient; and yet I have seen ignorant and careless surgeons rooting into the brain with a silver probe as if they were determined to find a foreign body, cost what it may. It is needless to say that such practice is criminal, and in no possible case called for.

The general treatment of such cases should in nowise differ from that laid down for the treatment of head injuries in general. The symptoms of concussion and compression, which are well marked and always

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* On one occasion, by the use of a gum bougie, Baron Larrey discovered a ball which had penetrated the forehead, and, travelling along the dura mater, had lodged at and under the occipital protuberance, whence it was successfully removed by trephining.—*Sédillot Medicine Operatoire.* Paris: 1853.

present, must be combated by using all the precautions which have been already pointed out.

We might now sum up, in a few words, the rational and successful treatment of gunshot wounds of the head. In concussion, unless there is evident sinking, leave the case to nature, and avoid both stimulation and venesection. When the patient is restored to consciousness, should inflammation of the brain threaten, if there be no congestion of the face, give opium to allay irritation. Should congestion be evident, use the antiphlogistic treatment, locally and generally, with ice applications to the head. In every case absolute quiet and rest are essential to successful treatment. All injuries of the head are serious, however trivial they may seem, inasmuch as violent inflammation often follows apparently slight wounds. *All, therefore, should be carefully watched* for some time even after the wound has cicatrized.

Chronic ostitis, or *periostitis*, resulting from gunshot wounds of the head, are of frequent occurrence, but possess no peculiar interest. Where the bones have been much denuded, either by the instrument inflicting the injury or by subsequent inflammation and suppuration, extensive exfoliations occur. I have seen cases in which, as sequelæ of erysipelas engrafted upon a gunshot wound of the head, the frontal or parietal bone was gradually isolated and removed. Such cases must clearly be left to nature, and the system supported by tonics and nutritious food when debility is present.

CHAPTER IX.

WOUNDS OF THE FACE—FRACTURES OF THE UPPER AND LOWER JAW—WOUNDS OF THE NECK—LARGE VESSELS AVOID THE PERFORATING BALL—WHEN LARGE ARTERIES IN THE NECK ARE DIVIDED, THE NECESSITY OF LIGATING THE BLEEDING MOUTHS IS URGENT.

WOUNDS OF THE FACE, when they do not implicate the brain, are not usually of a serious character. On account of the vascularity of the tissues, the severe cuts about the face, made by the sabre or by pieces of shell, heal very readily by the first intention, if the lips be kept in apposition by sutures or strips of adhesive plaster. The application of cold water for a few days will usually effect a cure. The excessive swelling which accompanies many injuries of the face, especially gunshot wounds and burns from explosion of powder, is readily controlled by cold water dressings. Although its appearances are so frightful, effacing temporarily the features, and exciting much alarm in the uninitiated, it runs its harmless course, moderated by the cold applications. and subsides at the end of a few days. The rapidity with which all wounds of the face heal has often been remarked, and the large number of such wounds make them, as a class, familiar to our army surgeons.

The most common injuries to the face from gunshot wounds are fractures of the upper and lower jaws from perforating shot. Round balls often become embedded in the soft, spongy bones of the face, but minie balls usually traverse the face and escape. When the bones of the face are struck by a grapeshot or a flat-

tened conical ball there may be great destruction of the features, followed by shocking deformity. But even when the bones are spiculated, exfoliation is not so general as in other portions of the skeleton—a few small pieces of bone escape from time to time, but such fragments as are firmly connected with the soft parts are permanently retained.

One or more of the senses are not unfrequently destroyed after gunshot injuries—sight or smell being often impaired, if not completely lost. Where the wound involves the orbit, the loss of vision is not only very probable, but there is great fear that the cause producing the injury, whether it be a ball, bayonet, or a sword point, may have perforated the thin plate of the skull, and, entering the brain, may induce fatal cerebral inflammation. Many cases of apparently trivial wounds of the eyelids have terminated fatally, and an autopsy revealed serious injury to the anterior lobes of the brain and its enveloping membranes. Such cases should be carefully watched, and any cerebral symptoms which may arise should be actively met by the antiphlogistic treatment, with absolute quiet.

From the great vascularity of all the structures composing the face, we would expect to have serious hemorrhage accompanying all injuries. For controlling this the astringent preparations of iron may be required, although, in by far the majority of cases, the bleeding ceases spontaneously. Should the carotids and other large arteries have escaped injury, the iron styptic will control the most annoying hemorrhage. The vessels are small and so numerous that the direct application of ligatures can not be made.

In fractures of the upper jaw the bones are always more or less spiculated, with one or more teeth loos-

ened or completely detached. Sometimes the teeth are separated from the gums, and, driven in front of the ball, are buried in the soft parts about the mouth, and are only detected after the formation of a fistula. As all portions are freely supplied with blood-vessels, union will take place among the fragments, even after considerable shattering of the bones. Unless the fragments are either completely detached or but slightly adherent, they should not be taken away, but should be replaced with care—as, in time, consolidation may take place, and very little permanent deformity will be left. Should some of these fragments die, they will be found loose, often as early as the sixth or eighth day, and should be removed. The cold water dressings, with an occasional dose of salts to relieve the excessive swelling, is the only medication required. The wound in the face, after a careful adjustment of the movable fragments, should be closed with adhesive plaster, and, with the use of coid water dressings for a few days, the case is left pretty much to nature.

When the soft parts, as well as the bones, are crushed, secondary hemorrhage may occur, should sloughing tissues come away. Formerly, the difficulty of restraining this loss of blood was so great as to require, in many cases, the ligation of the main vessels in the neck. We now find the local application of the perchloride or persulphate of iron an efficient remedy. Should necrosis follow injuries to the bones of the face, the dead pieces of bone should be removed as they become loosened; or a special operation may be undertaken for ridding the face of the local cause of trouble.

Fractures of the lower jaw are not a rare accident on the battle field, whether caused by shot wounds or

other casualties. The complicated character of the fracture does not prevent consolidation, which is effected in all cases, although usually connected with some slight deformity from displacement of the fragments. At times the entire jaw may be swept off by a round shot, leaving the mouth and throat exposed. One of the most fearful cases on record of such an injury is one in which the entire face was carried away by a cannon-ball, leaving nothing but the skull proper appended to the vertebral column. The opened gullet marked the former site of the features. The patient lived ten hours, and from the frequent change of position, and the squeezing of the hand when his was taken, it was thought that consciousness remained up to the time of death. Legouest reports a case in which the entire face was carried away by a cannon-ball, the eyes alone remaining of all the features. This patient survived the accident.

The surgeon accompanying the transports usually sends injuries of the face to the field infirmary untouched, or, should the lower jaw be broken, applies a folded handkerchief or band under it to support it. This fracture is permanently put up at the field infirmary in a pasteboard splint, well padded with carded cotton, and secured by a folded cloth or double-tailed bandage. One band passes over the vertex, supporting the jaws, while the other passes from the front of the chin behind the head, and then around the forehead, where it is secured by pins. Before the dressings are applied the wounds should have been examined carefully with the finger, and all perfectly detached spiculæ of bone should have been removed. From the excessive vascularity of all the tissues of this region the bones do not necrose as extensively as in other portions of the body, and portions of bone

which are attached to the soft parts very often consolidate. The surgeon must be prepared to meet much swelling and profuse salivation.

All gunshot injuries to the bones of the face being compound, suppuration is soon established, and the secretion of pus is copious. When the ball has perforated the buccal cavity, causing inflammation and salivation, it will add much to the comfort of the patient if his mouth be swabbed out daily with a piece of soft rag or sponge attached to a thin piece of wood. From the difficulty in swallowing, fluid nourishment must be prescribed. The constant thirst of those wounded will be relieved by small doses of morphine, or by acidulated drinks, made either with diluted nitric acid or vinegar. Injuries about the face are very liable to erysipelatous attacks, which, however, are readily controlled by the free use of the muriated tincture of iron—thirty drops every three hours often checking the progress of the disease by the end of the first day of treatment.

The most distressing injuries of the face are those involving vision. When a minie ball traverses the temporal regions, emptying both eyes, there is, of course, no remedy. The case is equally hopeless where injury to the optic nerve or optic ganglion occurs in the passage of a ball, although the globe of the eye may not have been touched. The general opthalmia induced will, by disorganizing all the tissues, destroy vision, in spite of treatment. When balls embed themselves about the face, they are found often with difficulty. Time may develop their situation, as the weight of the metal may cause them gradually to shift their position and approach one of the open cavities. When a ball crushes through the roof of the mouth, throwing the nasal and buccal cavities into one, and

affecting both articulation and deglutition, the serious annoyance can be corrected by adapting a gutta-percha plate to the roof of the mouth, which will restore the continuity of the cavities, and, with it, other respective functions. Should a ball in its passage injure the facial nerve, a permanent paralysis follows of all the muscles of the face supplied by it.

Wounds of the neck, with injury to the numerous large vessels which course through this constricted region, are among the serious accidents in battle. From the anatomy of this region we would suppose that a missile could not traverse the neck in any direction without destroying some important part. We find among the wounded, after every great battle, cases in which the neck has been perforated by balls traversing in every direction. Some of these are accompanied by violent hemorrhage, showing that, from the course of the ball, large vessels must have been injured; yet, should the patient rally from the first fainting brought on from shock and loss of blood, we find, usually, a spontaneous cessation of the bleeding, and the onward progress of the case becomes one of continued convalescence. I have seen conical balls perforate the neck antero-posteriorly, entering just above the sterno-clavicular junction, and passing in the midst, if not through, the largest vessels of the body, without producing a fatal hemorrhage. I have also seen them perforate the throat laterally, on a level with and just behind the angle of the lower jaw, and a cure equally follow. It is wonderful how the great vessels escape, or the rapidity with which clots form and the wounds of such vessels close. McLeod reports one hundred and twenty-eight cases, more or less severely injured in the neck, with but four deaths. Many, to be sure, die on the battle-field in a few moments after receiving

a serious injury to the large arteries; but, undoubtedly, many also recover.

The powerful iron styptics, with methodically applied compresses and bandages, are the only local remedies applicable on the battle-field, as the assistant surgeon, following the troops, has neither the time nor conveniences for ligating the bleeding mouths of the divided vessel, however urgently it may be needed. A finger thrust into the wound and retained for some time, has been successful in stopping the bleeding from apparently large vessels. Should the field infirmary be at no distance it may be possible, by pressure in the wound, to control the bleeding until the soldier can be conveyed to this point of safety, when, if the hemorrhage continue, an operation may be performed; but so seldom is this at a convenient distance, that if the bleeding does not soon cease spontaneously or be rapidly checked by the styptics used, the patient dies —no case of ligation of the large vessels of the neck having been yet reported from our battle-fields.

The precautions which were urged in discussing the means of arresting hemorrhage in wounds generally, must here be carefully applied; and should secondary hemorrhage occur, notwithstanding the careful application of the iron styptic, *the safety of the patient will then lie only in the ligation of both bleeding orifices.* The anastomosis of the blood-vessels in the neck are so free, and the vessels so numerous, that there would be much difficulty in diagnosis; and as the rule is to determine, if possible, the precise seat of hemorrhage, it can only be verified by the dilatation of the wound. A ligature upon the carotid artery, at a short distance both above and below the wound, has been reported a failure in controlling a hemorrhage, which was only checked by dilating the wound and ligating the artery at the point

injured. And at page 206 will be found the report of a case in which both common carotids were ligated for the injury of a comparatively small branch—the hyoid artery. The patient died. Had the rule of dilating the wound and of ligating both orifices of the bleeding vessel been followed, which is more imperative in neck injuries than in those of any other portion of the body, the patient would, most probably, have been saved. Should the large veins, when injured, persist in bleeding, they should be also ligated. In enlarging the wound, the incision will always be made parallel with the axis of the neck, so as to avoid injuring important nerves or blood-vessels.

Several instances have occurred in the Confederate campaigns where the trachea has been perforated by a shot or the larynx carried away. Such contraction of the air passage and difficulty of breathing follows upon this accident, as to force the patient to wear, permanently, a trachial tube, to protect him from attacks threatening suffocation. In such cases the voice is reduced to a whisper.

CHAPTER X.

WOUNDS OF THE CHEST—FLESH WOUNDS—EFFUSIONS WITHIN THE CAVITY WHEN THE PLEURA IS INJURED—WOUNDS OF THE HEART OR LUNG—A TRANSFIXED CHEST DOES NOT NECESSARILY IMPLY A PERFORATED LUNG—DIAGNOSTIC VALUE OF THE VARIOUS SYMPTOMS—HŒMOPTYSIS, DYSPNŒA, COLLAPSE, EMPHYSEMA—TREATMENT OF CHEST WOUNDS—HOW INFLAMMATORY COMPLICATIONS ARE TO BE COMBATED—THE TREATMENT OF A FRACTURED RIB—CONTUSIONS AND INJURIES OF THE SPINE.

WOUNDS OF THE CHEST, when taken as a class, are, perhaps, the most fatal of gunshot wounds. Many are shot down and die, more or less rapidly, on the battle-field from internal hemorrhage, with its accompanying suffocation, and are returned among the killed. Fraser, in an excellent treatise on chest wounds, based upon data obtained in the Crimea, states the mortality to have been twenty-eight per cent. of all chest wounds, and seventy-nine per cent. of those in which the lung had been injured. The Russian Crimean reports give as their mortality in chest wounds ninety-eight per cent., which is sufficient proof of the serious character of this lesion. The danger in wounds of the thorax is from visceral complications. Should the lung be severely injured, the case usually terminates fatally.

From the peculiar formation of the thoracic box and the curve of the ribs, balls, in striking, are often deflected from the straight line, and, after a longer or shorter course, escape without having penetrated the chest. Often the two openings correspond so accurately in direction as to establish a strong conviction of a direct passage through or across the thorax,

when the wound has been but a subcutaneous one throughout. I have seen an instance in which a ball, which had entered the chest just below the left armpit, was removed from a similar position in the right side as if it had traversed the thorax; its entire course having been subcutaneous, no inconvenience was experienced. This tortuous track can only be made by a ball striking at a considerable obliquity. Its direction is generally indicated by a reddish or purplish line under the skin, which, when followed by the finger pressed on the surface, imparts a crackling sensation, caused by air in the cellular tissue. Such injuries are usually simple, and require but little treatment. The cold water dressing fills every indication, and its application for a few days usually effects a cure.

A great amount of nervous shock often accompanies very trivial injuries of the chest. Many instances are mentioned by military surgeons in which balls had struck articles about the person of the soldier—the breast-plate of a cuirassier, or, perhaps, a book in the breast-pocket of a soldier's coat—and had fallen to the ground without even touching the skin, yet the soldier had been knocked down breathless, and, in some cases, did not recover completely from the shock for days. In some of the cases the lungs are so much concussed by the blow that blood escapes from the mouth as in perforating wounds.

Where a ball traverses the outer side of the chest antero-posteriorly, although the cavity may not have been opened, there may be the very serious complication of injury to the axillary artery as it courses under the great pectoral muscle. Pressure with the thumb upon the subclavian vessel above the middle of the clavicle as it passes over the first rib, will con-

trol the bleeding sufficiently to allow the wound to be dilated, when both bleeding orifices should be secured.

Should the ball have penetrated the chest, it may course for some distance between the ribs and their lining membrane, when it may either escape from the cavity and be found under the skin, or remain capped by the pleura. Such cases may give no trouble, or pleuritis may ensue, which the rational signs, with ausculation, will detect, and an antiphlogistic course, accompanied with the free use of opium, will readily subdue. Opium, when used in large and frequently repeated doses, possesses other virtues than merely allaying pain and quieting nervous symptoms. It combats, directly, inflammation, and, by the great control which it exercises over the brain and circulation, becomes, in the treatment of the serious sequelæ of wounds, one of the most, if not the most, valuable remedy of the materia medica. When given in combination with nitrate or carbonate of soda, its nauseating effects are counteracted.

The evil which the surgeon fears from perforating wounds, followed by inflammation, is that a serous or sero-purulent effusion may rapidly accumulate in the thoracic cavity, and destroy the patient. So rapidly is this fluid formed, that the chest has been known to fill in twenty-four or forty-eight hours—the fluid compressing and condensing the lung against the vertebral column. In expanding the chest, it will be found that as soon as a thin layer of fluid is effused into the cavity, separating the lung from the thoracic wall, the respiratory murmur becomes very feeble, and will altogether disappear when the cavity is filled. At the same time respiration becomes much embarrassed, with marked dyspnœa. Percussing the side will now give a dull, heavy sound, instead of the ordi-

nary clear, sonorous one of health; and the position of the patient must vary the sound by the gravitation of the serous collection unless the cavity is filled with fluid. The lung is condensed and flattened against the vertebral column, and is temporarily impervious to air; under a long continuance of the pressure, it will become permanently consolidated. The increase in the circumference of the chest, and the fulness of the intercostal spaces, with the absence, to a great extent, of respiratory movements upon the affected side, the displacement of the heart from its usual position—being found on the right side, where the effusion fills the left pleural cavity, and *vice versa*—and great oppression of the breathing, with inability to lie upon the healthy side, are conspicuous symptoms of a distended cavity.

The quantity of fluid thrown out varies from a few ounces to several pints. When the natural dimensions of the cavity are not sufficiently extensive to accommodate it, it forces the mediastinum over to the sound side, interfering with the action of the healthy lung, while an encroachment may be equally made upon the abdomen.

When, after gunshot wounds, accompanied by distressing symptoms of dyspnœa, the surgeon recognizes such collections as rapidly forming in the chest, an early evacuation will be required. Should the collection be purulent and show a disposition to point, an opening for the escape of the fluid should be made at the point which nature indicates; but, in cases of excessive effusion, the broad intercostal space, between the sixth and eighth ribs on the right, or between the seventh and ninth on the left, might be the point selected. The instrument, usually a trocar and canula, should be introduced at right angles to

the chest and near the upper edge of the rib, toward its angle, in a line continuous with the posterior border of the armpit. As this puncture corresponds with the lowest portion of the cavity, the chest can be perfectly drained through it.

In all gunshot injuries of the chest, the most serious complication is injury to the lungs or heart, and it is often difficult to detect at first such lesions. Notwithstanding the many infallible signs laid down by authors, experience teaches us that no one symptom is sufficient for establishing a diagnosis. When the heart is injured, although instantaneous death does not take place as a general rule, the wounded man lives but a short period. The pericardium soon becomes filled with blood; the action of the heart is mechanically impeded, and, sooner or later, depending upon the size of the wound and the facility for letting out blood, it ceases its pulsation. As reports of cases are not very rare in which small, oblique, incised wounds of the heart have been recovered from—and even gunshot wounds of this organ, perforating its cavities, have escaped with life—a wound of the heart is not considered necessarily a fatal accident. When the pericardium is perforated and the heart not injured, a successful result may readily be obtained by a judicious course of treatment, which will keep down inflammation, with its effusions of lymph and serum. Close carefully the outer wound, so as to induce healing by the first intention, but otherwise leave the case to the *vis medicatrix naturæ,* avoiding all excitants, keeping the patient quiet, and instituting a non-stimulating diet.

The lung often escapes injury when, from the position of the wounds of entrance and of exit, with the certainty of the cavity being transfixed, the natural

belief would lead to a perforation of the organ. A straight line between the wounds passes evidently through the substance of the lung, but the ball, in perforating the rib, may have been deflected from its straight course, and following, perhaps, the inner curve of the chest, and meeting with some resistance, had forced its way through the chest—either appearing under the tough, elastic skin, or cutting its way out without having touched the contained organs.

The lung may, on the other hand, be severely injured when no perforating wound exists. A blow by a spent ball or a fragment of shell may make a very superficial wound or bruise in the skin, and yet may shatter one or more ribs, driving the spiculæ into the lung, lacerating, to a greater or less extent, its substance. Even without fracture of the ribs, the concussion or blow may have been sufficiently great to have caused irreparable injury.

The following cases, extracted from a Memoir on Amputations, by Baron Larrey, will exhibit the extent of internal injury from a spent ball without external indications of mischief:

"At the Siege of Roses there were brought from the trenches to the ambulance that I had established at the Village of Palace, two gunners, having nearly the same kind of wound; they had been struck by a ball of large calibre, which, when nearly spent, had grazed posteriorly their two shoulders. In the first I discovered a slight ecchymosis over the whole posterior part of the trunk, without any apparent solution of continuity. He was hardly able to breathe, and spit up a great quantity of vermilion and frothy blood. The pulse was small and intermitting, and the extremities cold; in short, he died an hour after the accident, as I had prognosticated. I opened the body in the

presence of M. Dubois, inspector of military hospitals. The skin was unhurt; the muscles, the aponeuroses, the nerves and vessels of the shoulder, were broken and torn, the scapulæ fractured, the spinous processes of the corresponding vertebræ of the back and the posterior extremities of the neighboring ribs fractured; the spinal marrow was distended, the parenchyma of the lungs toward the corresponding points were lacerated, and a considerable effusion had taken place into both cavities of the thorax. The second gunner died, with the same symptoms, three-quarters of an hour after his entrance into the hospital. On opening the body the same mischief was perceived as in the first."

The severity of the symptoms will depend upon the portion of the lung injured, and also the depth of the wound in the lung. Where a ball traverses the peripheral substance of the lung, whether it be at the apex or base, where the vessels are broken up into their minute ramifications, the case is usually less serious, and much more likely to recover, than when the root of the lung is perforated. The injury in this case would implicate the large vessels passing to and from the heart, and hemorrhage may be so rapid and excessive as to be immediately fatal. It is on account of the loss of blood that the most conspicuous symptoms arise, viz: hemorrhage, collapse, cough, and dyspnœa, or oppressive breathing.

The patient may be at once suffocated by a large quantity of blood filling up the thorax and preventing the ingress of air into the lungs. Usually blood passes from both the mouth and the wound. When the smaller vessels are injured, that from the mouth is frothy and florid, and is brought up by a short, tickling, harassing cough. Where the vessels injured are of larger size, the blood comes up from the

chest in a purer condition and in larger quantity, at times in nearly a stream, filling the mouth as rapidly as it could be spit out, and threatening suffocation. The size of the dark-colored stream pouring from the wound depends upon the position of the orifice. Where the orifice is situated low upon the chest, and is large and direct, the effusion into the cavity escapes freely—the symptoms of collapse may soon appear, but suffocation is prevented; while from an injury in the upper portion of the chest, particularly if small and oblique, the thorax may fill with blood, and suffocation becomes imminent, without much external loss. The danger from hemorrhage is greatest during the first twelve hours, and is pretty well over by the second day. The bleeding may, however, continue for eight or ten days, gradually diminishing in quantity. With the flow of blood from the wound air often escapes, and the two symptoms are considered unequivocal proof that the lungs have been injured—their absence does not prove the contrary. We meet with cases of perforation of the lung terminating fatally at the end of thirty-six or forty-eight hours, in which collapse had been the only conspicuous symptom—no hemorrhage may have been present either from mouth or wound—yet an autopsy will reveal the chest filled with blood.

The mere loss of blood from the lung is no certain indication that the organ has been injured, as bloody expectoration is a common symptom of blows upon the chest, and arises from a sudden concussion of the organ. Fraser, in his recent work on gunshot wounds of the chest, places less value on hæmoptysis than do other military surgeons. Guthrie considers it a proof of lung wound; so do Baudens, McLeod, Stromyer, Ballingall, and others. Fraser's experience in the Cri-

mea gives, in nine fatal cases in which the lungs were wounded, but one instance of hæmoptysis, and in seven fatal cases in which the lungs were not injured, two had spitting of blood. In twelve cases of recovery, three had hæmoptysis. From our large experience of perforating chest wounds we would infer that the spitting of blood is a very deceptive diagnostic sign of lung wound. When it is rapidly brought up by mouthfuls, it becomes an important symptom.

The discharge of blood from the wound is sometimes occasioned by injury to the intercostal vessel; but this is so rarely the case that McLeod states that he neither saw nor heard of an instance during the Crimean war.

The most distressing symptom is *dyspnœa*, which may appear soon after the injury has been received, or perhaps not until some days have intervened; in certain cases of undoubted lung injury it may not have been present at any time. This symptom is sometimes very intense—from moral or other causes—when the lung is not wounded, and it may be but slightly marked, or even altogether absent, when the lung is seriously implicated. This difficulty in breathing depends, in some instances, upon the direct pressure and condensation of the lung by air or by fluids. When the chest has been opened by a ball the lung does not collapse, as is generally supposed, but, if the opening is sufficiently large, can be seen moving to and fro against the thoracic walls simultaneously with respiration; and, as a proof of the continued action of the lung, and its inflation with air, it is sometimes found protruding from the orifice, forming a hernia of the organ. Even when the lung has been completely perforated, it does not necessarily collapse; but as blood escapes into the pleural cavity, the lung

may be gradually pushed back and condensed against the vertebral column. with all the accompanying symptoms of dyspnœa. From injury to the lung and continued pumping of air into the pleural sac, when an opening exists in the chest for its ready escape, we sometimes find similar difficulties in respiration induced.

Emphysema is a symptom of injury to the lung upon which much importance has been placed, and yet is a sign which our extensive experience shows to be rarely present. It may be occasioned by any circumstance which admits air into the pleural cavity, where, being compressed by the action of the lung and walls of the chest, it is forced out through the wound. Should a ready exit not be offered for its escape, or should any obstacle exist in the form, size, or direction of the wound, the air would be forced into the cellular tissue. Owing to the free communication in the interstices of areolar tissues, it diffuses itself widely and rapidly. Should a perforated wound from a ball or other weapon allow air to enter the pleural cavity, whether the lung be injured or not, emphysema might appear. It is not so frequently met with after gunshot wounds, because the large orifice of entrance offers a free exit to the contents of the cavity. It is a much more common accompaniment of oblique punctured wounds, and is also met with in cases of fractured ribs, when sharp spiculæ of bone have abraded the surface of the lung and allowed air to escape from the air tubes into the cavity. As it is found either with or without lung injury, it can not be of much value in diagnosis. The injured lung, in gunshot wounds, does not often permit air to escape for any length of time from its wounded surface, as an imme-

diate extravasation of blood into the bruised tissue closes up the small air tubes, and shuts off communication with the cavity.

Another symptom of great value is *collapse*, depending upon loss of blood. It is well known that all the blood of the body must continually pass through the lungs; and should the vessels composing the parenchyma of this organ be extensively opened, the loss in even a short period must be excessive. It is not surprising, therefore, that the patient should soon become cold, pale, and faint—with feeble, small, and irregular pulse, and with rapid tendency to syncope. This is nature's effort to check further loss; and although sometimes successful, often gives but temporary security. The surgeon tries to induce this condition for a similar purpose.

From the consideration of the above symptoms, we are induced to believe that no one symptom is pathognomonic of injury to the lung; it is rather from a combination of phenomena that any certainty in diagnosis is attained. The immediate danger and intensity of the symptoms will depend upon the depth of the penetration. Where the chest is only superficially wounded, although the force of the blow may be sufficient to produce an amount of shock of shorter or longer duration, and blood may be expectorated from the concussion of the lungs, the symptoms will be trivial. The pain of the bruised tissues will pass off in a few days, and with it all the accompanying symptoms. When the chest has been opened without injury to the lung, heart, or intercostal vessels, the symptoms are also trivial; and unless inflammation of the pleura, and subsequent effusions of serum or pus should ensue, the case will equally require but little

treatment. When the lung is implicated, and especially when severely wounded, other symptoms are more or less conspicuously present.

Soon after the reception of a severe wound blood pours from the injured vessels, and escapes both into the air tubes and into the pleural cavity. From the air vessels it is brought up and expectorated, in greater or less quantity, as in hæmoptysis, while, at the same time, it flows from the external wound in the side. If the openings in both lung and chest be free, the blood escaping, both by the wound and the mouth, is mingled with air when the patient coughs. The air is forced from the chest wound in such a blast as to extinguish a lighted candle. With the loss of blood, the surface becomes cold and bedewed with a cold perspiration; the pulse is weak and tremulous, becoming more and more enfeebled until syncope comes on, which temporarily checks the excessive bleeding. Should the orifice in the side offer an imperfect escape to the blood, and the vessels injured be large, it collects in the pleural cavity, rapidly encroaches upon the lung, which is forced back against the spinal column, and, by compressing the opposite side of the chest through the mediastinum, threatens suffocation. The eyes protrude, nostrils expand to their utmost, the arms are thrown about in every direction, and frightful struggles for breath appear in every feature. These are the cases which, if not relieved by the free escape of blood externally, will, in a few moments, terminate fatally by suffocation. Where the bleeding occurs from small vessels the pressure is so gradually increased that the above symptoms are not observed.

The simple cases of chest wound, requiring no immediate attendance, will be sent on to the field infirmary,

and although the wound has evidently transfixed the chest, if no urgent symptoms exist, the case requires no treatment from the ambulance surgeon. The surgeon at the field infirmary removes any rough field dressing, and, where foreign bodies are suspected, examines the wound with the finger. If the orifice be not sufficiently large to permit a thorough search, he dilates it with a probe-pointed bistoury.

In perforating chest wounds, unless urgent symptoms of dyspnœa are present, the general treatment is purely of the expectant plan. The wound having been carefully closed with a strip of diachylon plaster, the patient lies on the wounded side, so as to throw the lung against the orifice, hoping that it may adhere to the chest at that point, and so close permanently the cavity; he also finds this the most comfortable position. He is kept quiet; all excitants are avoided; abstemious diet is instituted; veratrum viride or digitalis may be given to control the action of the heart; opium is freely administered to quiet the constant hacking, tickling cough, and cold water dressings are applied to the chest. With such treatment and careful watching, seeing the patient, if possible, every one or two hours, we await the development of symptoms. The accurate closure of the wound excludes the admission of air, to a certain extent prevents emphysema, and also the rapid decomposition of the escaped fluids in the cavity, which indirectly prevents inflammation.

If it be a shot wound, with a single orifice, and portions of the clothing be found wanting, the wound should be examined for foreign bodies. If found, extract them; if not detected, then close the wound carefully with a strip of diachylon, and apply the water or ice dressing.

The search for foreign bodies must always be made with the finger, and should never be protracted. Should nothing be found after a moderate, intelligent search, close the wound and await developments. This examination should be made before reaction comes on. Should we not see the patient until he is feverish, all examinations must be absolutely forbidden until reaction has subsided and suppuration be well established.

It is well known that balls, etc.,—even pieces of clothing—have often been found encysted in the lungs years after they had been deposited; and in some instances these articles have been expectorated, during a severe spell of coughing, after a long interval from the receipt of the injury. Although always desirable to remove these, a prolonged search may entail such an amount of injury as to destroy all hope of saving the patient, when the presence of the foreign body would not have been necessarily incompatible with life, or even health. Besides, when suppuration is well established, we have a second and much better opportunity for a careful examination, without much fear of doing injury.

A case in point was reported to the association of army surgeons at their meeting in February, 1864, by Surgeon Thom, as communicated to him by Surgeons Selden and Moore:

"The patient, of scrofulous habits, twenty-two years of age, was leaning on his gun, the muzzle in contact with his left side, when it exploded, tearing a hole in the chest of three or four inches in diameter, carrying with the load of shot fragments of the third, fourth, and fifth ribs, and the whole of a very heavy English gold patent-lever watch, except the ring to which the chain was attached—which, singular to say, was found

in the lining of his waistcoat, on the right side. Dr. Selden found the patient apparently about to expire, and, from the impending suffocation upon the ingress of air within so large an opening, he could make no exploration of the wound. Closing the wound with a large compress and bandage, opium and stimulants were freely administered. Reaction took place, and in a fortnight sufficient adhesions were established to permit exposure of the cavity of the wound, and to recognize and to remove the metal face of the watch, from some six inches at the bottom of the wound. For several weeks fragments of the watch continued to present themselves and were extracted—some from the diaphragm, others below the clavicle. The lung collapsing was not torn to pieces, though wounded in several points. Both the heart covered by the pericardium and the aorta were exposed to view and to touch. Suppuration was enormous—hemorrhages frequent. The collapsed lung became bound down by adhesions; the whole side of the thorax sunk. Sustained by every article of nutritious food calculated to supply an inordinate appetite, the patient's recovery was slow until the wound, progressively reduced, could only admit a female catheter. Fragments of the watch and bone, together with shot and other extraneous matters, continued for some time to be ejected by expectoration, with sputa. The patient now possesses every part of the watch except the hands, a considerable portion of the small works having been expectorated. The openings into the lung were of sufficient size to allow a current of air to escape, and, if directed against the flame of a candle, to extinguish it. The patient's health continues feeble, but is as robust as it had been during the past five years."

When active hemorrhage occurs within the cavity, two diametrically opposite courses are recommended by military surgeons of experience. Many advise that the wound should be kept open, so as to allow the free ingress of cold air into the cavity, which, as a hœmostatic of great value, may be influential in constringing the injured blood-vessels and stopping the hemorrhage. Other surgeons recommend that, in such cases, the orifice be closed with extreme care, even paring the edges of the wound and bringing the parts together by silver sutures, so as to ensure union by the first intention. The object of this course being to retain the blood within the cavity of the pleura, allowing it to fill this space, compress the lung, and with it the bleeding vessel, so as to stop the further loss of blood. Should the rapid accumulation of blood in the cavity of the chest cause serious dyspnœa, the orifice may require opening to allow the fluid to escape, and thereby relieve the pressure upon the lung.

"The effect of this escape of blood from the cavity of the chest was exemplified in the case of Major Wheat, who was shot through the chest at the first Battle of Manassas, the ball entering in at one armpit and escaping from the other on a level with the nipple. Soon hemorrhage caused great oppression and, finally, fainting. When he partially recovered his consciousness he found himself surrounded by his men, who, believing him dead, had stripped his body of every vestige of rank, so as to prevent recognition by the enemy. One of his men (a powerful sergeant), determined to save the body from indignities, had seized the major's arms at the wrists, and, with the assistance of a comrade, had slung the body over his back, drawing the arms of the supposed dead man over each shoulder, and in this position started off from

the battle-field. Major Wheat was himself a powerful man, and his weight, in addition to his chest being drawn forcibly against the broad back of his sergeant, so increased the pressure upon his lungs as nearly to extinguish the flickering spark of remaining life, when he suddenly felt a gush of blood and air from both armpits, followed by such immediate relief that he found his breath returning, and when he reached the ambulance wagon he could stand up. Arriving at the hospital, he found that he had so far recovered, under this rough treatment, that he could walk with assistance. Quiet, with but little medication, soon completed the cure, and, in course of time, enabled the major to resume his command.

In drawing off the contents of the chest, should syncope threaten we should close the opening and await another opportunity. The collection is retained in certain cases, when no marked dyspnœa exists, for the purpose of retarding and finally controlling the bleeding, by the pressure which the pent-up fluid exercises upon the lung and its injured blood-vessels. After the third or fourth day, the tendency to hemorrhage having ceased, and the wound having already commenced to suppurate, the adhesive plaster is removed and the effusion is allowed to escape. If air has been admitted into the cavity the exuded blood has decomposed, and, mingled with serum and pus, makes, for the first few days, a copious and very offensive discharge. Gradually the escaping fluid loses its dark color and offensive smell, and assumes the appearance of healthy pus. Formerly much care was taken to favor the flow of fluids from the chest, and dilation of the wound was the recognized rule; now, unless serious oppression of breathing exists, threatening suffocation, the opposite treatment is the

one urged, to exclude air, and, if possible, retard decomposition—as this deterioration of the effused fluids is more injurious to the system than the advantages obtained by their ready escape. From this time onward, simple water dressing will be the only local treatment required for the wound.

If the orifice from a punctured wound has healed, with escaped blood remaining within the chest, the collection, if small, should be ignored, as it will gradually be absorbed. If the extravasation be very extensive, particularly if air had previously entered the cavity, it may be necessary, in a few rare instances, to withdraw the effusion by making a puncture at the most dependent portion of the chest. This operation, unless called for by urgent or distressing symptoms, should, in no case, be hastily performed, but should, on the contrary, be delayed as long as possible.

In collapse we have already recognized a valuable aid for checking hemorrhage, and its remediable advantages should be appreciated. As a symptom it must be carefully watched, and should it threaten to stop the action of the heart, external stimulation must be freely used; but the internal stimuli must be administered only in small quantity, and with caution.

European writers on the subject of chest wounds agree that the lancet is the only safe reliance in cases of dyspnœa, or internal hemorrhage, and they urge that, in the incipient treatment, before the patient is borne from the battle-field by the litter-carriers, the veins of both arms should be opened and blood be allowed to run off freely, which they consider as the best means of stopping the effusion within the thoracic cavity. This venesection they do not hesitate to repeat whenever dyspnœa shows itself, and recommend that, to obtain its best results, it should be carried to syncope.

In connection with this, the most active antiphlogistic treatment is instituted. The results reported by them indicate that this injury is among the most fatal of gunshot wounds. Of four hundred and seventy-four cases reported by McLeod of injuries to the chest, one hundred and twenty-six died, which is a frightful mortality, when it is taken into consideration that all wounds about this region were included, only a small proportion being perforating wounds with injury to the lungs. Among the officers there were fifty-four cases of chest wounds, of which twenty-one had apparently perforated the cavity. Of these latter fifteen died—a mortality of 71 per cent. In our experience perforating wounds of the chest, even those in which the ball had clearly traversed the lung, are, by no means, so fatal an injury as gunshot wounds of other regions of the trunk. Under the expectant plan, which consists of little more than careful nursing, avoiding all active treatment, more especially bloodletting, we have succeeded in saving the majority of our wounded. Surgeon Thom, in a recent report to the association of army and navy surgeons, gives a list of seventy-four cases of gunshot wounds perforating the chest and transfixing the lungs, as reported by Confederate army surgeons. Of these twenty died —a mortality of 25 per cent.,—which indicates clearly the advantages of the expectant course of treatment for this as well as for all gunshot wounds, over the heroic and fatal treatment of former years. As far as could be ascertained, bloodletting had been resorted to in but one case of perforated chest wound.

When the immediate dangers have passed, the next in order is inflammation of the lungs and pleura. Neither of these conditions differ in any very material respect from the idiopathic varieties of the disease,

except that traumatic pneumonia is usually circumscribed to narrow limits. As the cause of pleuritis is a direct injury to the membrane, and, in the majority of instances, as air has been admitted within the cavity, the effusions which accompany the inflammation soon become purulent, and, in time, false membranes of considerable thickness line the inner surface of the ribs.

The treatment for either pneumonia or pleurisy, when occurring from a gunshot wound, does not differ from the treatment of the disease from any other cause. McLeod's experience is in favor of early, active, and repeated bleedings, with cool drinks and abstemious diet, recognizing, at the same time, however, that many excellent recoveries have been made without recourse to the lancet. Guthrie uses the lancet, which he designates the first and most essential remedy, and which he says should be resorted to in every case. The venesection, which he repeats whenever the inflammatory symptoms show an increase, is vigorously followed by large doses of tartar emetic in pneumonia, and calomel in pleurisy—the object being to affect the gums as soon as possible. This is the treatment of the old school, which recent experience does not uphold. Guthrie states "That in the Crimea bloodletting had not been so favorably viewed, nor found so serviceable, nor so necessary." Fraser, from Crimean experience, states that, in the prevention and reduction of inflammatory action, in perforating wounds of the chest, venesection is not demanded. He advises its use only when the pulse is full, strong, and labored—a condition not often met with. "When the heart and pulse are both weak—a common condition after severe wounds —in our experience the abstraction of blood will occasion a complete prostration of strength, and may be fatal.

There is no reason for changing the plan of treatment, already discussed in detail, for combating inflammation following gunshot wounds, and which is equally applicable to chest wounds. Even when the lung is inflamed, we prefer the mild, antiphlogistic and expectant treatment to the spoliative. The large success in the treatment of perforating chest wounds in the Confederate hospitals puts forth, in a strong light, the powers of nature to heal all wounds when least interfered with by meddlesome surgery. Absolute rest, cooling beverages, moderate nourishment, avoiding over-stimulation, with small doses of tartar emetic, veratrum, or digitalis, the liberal use of opium, and attention to the intestinal secretions, will be required in all cases, and in most will compose the entire treatment.

A certain degree of pleuritis is expected and desired in penetrating lung wounds, to establish adhesions between the injured lung and thoracic wall, which will at once isolate the injured part, and prevent inflammatory sequelæ. As gunshot wounds do not usually close rapidly, but suppurate, often permitting the access of air within the thorax, the suppuration may be profuse and long-continued. We must remember this in the treatment, and not use depressing agents. When the pleuritis is excessive and general, both false membranes and the rapid accumulation of fluid are to be anticipated. If the external wound is still open, the position in which the body is placed is very important, as it will allow of the ready escape of the effusion, which is, at first, serous, but soon becomes purulent. Position and constitutional support will form the basis of treatment. If the pus could have a constant outlet for escape, and accumulation within the cavity could be prevented, the false membranes would tie the lung

to the thoracic wall at an early period, and, by obliterating the affected portion of the pleural cavity, prevent further discharge. Should the wound from which pus pours daily be in the upper portion of the chest, and auscultation and percussion indicate that the entire cavity is filled with fluid, it would hasten the cure to establish a counter-opening from the most dependent portion of the cavity, by which the drain would be facilitated.

The chapter on the treatment of suppurating wounds lays down general laws for counteracting the injurious influences of long-continued suppuration.

Penetrating wounds of the thorax occasionally remain fistulous for an almost indefinite period—which is caused by a failure of general adhesion between the costal and pulmonary pleuræ. A kind of pouch is found, lined by a false membrane, from which a purulent lymph is continually secreted. After empyema the chest contracts, the walls sink in, the diaphragm rises high on the affected side, the spine becomes contorted, air enters indifferently into the lung, auscultation indicates no respiratory murmur, little or no respiratory movements are seen in the chest, and a portion of the respiratory apparatus is rendered useless to the economy. Usually this long train of symptoms terminate fatally in phthisis, although in the progress of ordinary gunshot wounds of the chest and lungs perfect health is regained in the majority of cases.

In cases of fractured ribs, from gunshot injuries, which is a very frequent complication of perforating wounds of the chest, the bone is usually spiculated, and some of the fragments may accompany the ball in its onward course. Upon examination with the finger these irregular fragments can be detected, and should be removed. If necessary, the outer wound might be

enlarged, to facilitate this important step. The danger is not so much from the breaking of the bone, but from the displaced, sharp fragments seriously injuring the pleura and lung. Where the ball has fractured the rib without perforating the cavity, the digital examination should be made with extreme caution, so as not to force sharp spiculæ through the pleural lining, thereby converting a simple into a serious accident. When these are removed the wound should be closed with a wide adhesive strap, and cold water dressings applied. Whether symptoms indicate injury to the lung or not, a broad band must be applied and firmly drawn around the chest, in order to control the thoracic movements and allay the pain. This pain is caused chiefly by the movements of the broken ribs driving the sharp fragments into the sensitive tissue. Control the movement by a broad bandage, and pain is at once relieved. An opening is made in the broad band to correspond with the wound, so that the discharge can escape freely without interfering with the fracture dressing. Where the spiculæ are not displaced, a broad adhesive strap is the only local apparatus required. Necrosis of the rib commonly follows a gunshot fracture, and may require a subsequent operation for its removal.

When an intercostal artery is divided the bleeding point will be discovered by drawing out the lips of the wound with a tenaculum, when the vessel should be secured. All military surgeons agree that this is an operation more frequently spoken of than performed, many of extensive experience having never seen a case.

When foreign bodies, as balls, pieces of bone, cloth, wadding, etc., are driven into the pleural cavity, unless removed, they may produce fatal results by inflamma-

tion and exhausting discharges. A loose ball can be sometimes felt by the patient, and its movements often detected by the stethescope. Through an opening, made at the most dependent portion of the chest, the foreign body has been successfully removed.

Among the most fatal injuries are found *gunshot wounds of the spine*, whether inflicted by shot or portions of shell. A concussion of the spinal cord, produced by the explosion of a shell in the immediate vicinity of the back, is an injury not unfrequently met with in field practice, having, as its most conspicuous symptom, pain in the vicinity of the injured part, accompanied by impairment of mobility and sensation of the lower limbs, amounting at times to paralysis. These annoying conditions are very persistent—patients thus afflicted being often the inmates of military hospitals for months. As the result of such a concussion, blood may be effused within the sheath of the cord, causing a similar paralysis from pressure as was seen in hemorrhage within the skull. A chronic and eventually fatal myelitis may supervene upon this extravasation, increasing and extending the paralysis so as to include the bladder and rectum, with involuntary escape of feces and retention of urine. The inflammation may run on to complete disorganization of the cords. The treatment from which relief will be obtained is in keeping the patient perfectly quiet in the recumbent position, using blisters or cups to the back, and applying stimulating embrocations to the spine. The urine should be drawn off twice daily. When the bladder is paralyzed and the rectum emptied daily by an enema, so as to prevent the continued escape of small quantities of fecal matter, extract of belladonna, in half-grain doses, is supposed to exercise a decided influence in controlling

congestions of the spinal cord, and may be used with benefit. When the symptoms are slowly subsiding, the only remaining evidence of injury being the debility of the lower limbs, convalescence can be hastened by the internal use of sulphate of strychnia.

Those cases in which balls embed themselves in the bodies of the vertebræ without injury to the cord are not so dangerous, although a weakness of the back, with severe pains similating rheumatism, torment the patient, and may eventuate in serious derangement of the economy.

All gunshot wounds of the spinal column do not destroy life with the same rapidity, although they are all considered necessarily fatal. By examining the anatomical distribution of the many nerves which take their origin from this nervous centre, we will find that many of the important organs of the trunk are supplied from this source. Commencing from above, after the muscles of the neck are supplied, are the phrenic nerves, which give motion to the diaphragm. They arise from the vicinity of the third cervical vertebra. From the lower cervical region originate the nerves of the upper extremity; from the dorsal region the intercostal muscles receive their nervous supply; and from the lumbar region, besides the muscles of the lower part of the trunk and those of the lower limbs. the bladder and rectum are dependent for their powers of action upon nerves originating here.

Should a fragment of shell or a ball lay open the lower portion of the spinal column, the immediate symptoms would be paralysis of the lower limbs, with retention of urine and involuntary discharges of feces, inasmuch as there is no power in the sphincter muscles of the anus to retain the contents of the rectum. The surface of the lower portion of the body

and extremities loses temperature, and with it a gradual impairment of nutritive activity, in which the entire economy in time sympathizes. The skin of the paralyzed portion assumes a cadaveric hue, with tendency to congestion at different points, eventuating in a lifting of the cuticle and a gangrenous condition. Should the patient survive sufficiently long, mortification attacks all those paralyzed portions of the body compressed in the attitude of lying, and immense sloughing bed sores assist to exhaust the patient. While these changes are going on, some of the contents of the over-distended bladder, filled with decomposed urine, is constantly escaping—there being no power in the paralyzed neck of the bladder to retain it. The urine becomes alkaline and ammoniacal, irritating the mucus lining of the bladder, which assumes a condition of chronic inflammation, with thick, ropy discharges. Should not inflammation and disorganization of the spinal cord occur to destroy life more rapidly, the patient may live for weeks or months, but is gradually worn out.

Where the injury to the spine is located in the dorsal region, there are present, besides the symptoms just enumerated, paralysis of the abdominal muscles, and all those intercostal muscles situated below the seat of injury. This complication interferes more or less seriously with respiration, which meets with no assistance from the abdominal and intercostal muscles, but must be carried on solely by means of the diaphragm, the thoracic cavity being contracted by the depressed ribs. In consequence of this paralysis, respiration and the arterialization of the blood is very indifferently performed. Congestion of the lungs is gradually induced, and the patient rarely survives this accident more than from two to three weeks,

although he is usually carried off a few days after the receipt of the wound. As the point of injury ascends, the spinal cord involving the upper extremities, the respiratory movements are more embarrassed, and should the injury be located in the vicinity of the third cervical vertebra, and at the origin of the nerves supplying the diaphragm, death is immediate from asphyxia, as all respiratory movements are completely paralyzed.

In any case of gunshot injury of the spinal column, even in its lower portion, should inflammation of the cord and its meninges be established, which, when it occurs, ordinarily makes its appearance four or five days after the receipt of injury, death occurs speedily from the disorganizing effects of this inflammation. Where the spinal cord has been injured by a ball or portion of shell, the patient dies, no course of treatment offering any prospects of success. The course to be pursued is altogether palliative—keeping the bowels and bladder emptied, and allaying pain by administering some of the preparations of opium. This class of injuries is by far the most fatal of all gunshot wounds.

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CHAPTER XI.

WOUNDS OF ABDOMEN—FLESH WOUNDS—NEVER PROBE PERFORATING WOUNDS OF THE ABDOMEN, AND, ESPECIALLY, NEVER ATTEMPT TO SEARCH FOR FOREIGN BODIES WHICH HAVE PASSED BEYOND THE ABDOMINAL WALLS—SEW UP INTESTINAL WOUNDS—DILATE WOUND IN ABDOMEN WHEN NECESSARY TO RELIEVE STRANGULATION AND TO FACILITATE REDUCTION—WHERE THE LARGER VISCERA ARE INJURED, RECOVERY IS RARE—AVOID USING PURGATIVES WHEN THE INTESTINE IS WOUNDED—PERITONITIS A COMMON CAUSE OF MORTALITY—WHERE THE INTESTINE IS MUCH CRUSHED, LEAVE IT OUT OF THE WOUND, OR EXCISE THE CRUSHED PORTION, AND CLOSE THE INTESTINAL WOUND BY SUTURES—IN WOUNDS OF THE BLADDER, CONTINUED USE OF CATHETER ESSENTIAL.

Sir Charles Bell has remarked that, although *abdominal wounds* bore a fair relative proportion to other wounds, immediately after a battle, a few days sufficed to remove them—so that, by the end of the first week, there was scarcely one to be seen. This rule is only partially verified in modern surgical experience, as many cases of intestinal wounds recover. In cases of perforating wounds of the abdomen, those who have received wounds of the large abdominal viscera, such as the liver, stomach, kidneys, and bladder, are most frequently lost—the exceptions of restoration to health being not very numerous. Like wounds of the chest, where the abdominal walls are not perforated, but the entire track of the ball lies in the thickness of the muscles, the wound is simply a flesh wound, of a comparatively trivial character, and should be treated accordingly. The track of the ball may not always be in a straight course, as the muscles, or their tendinous

portions, when in action, offer sufficient resistance to divert the ball.

A perforating wound of the abdomen is equally dangerous with those of the chest, as peritonitis is apt to supervene. If the perforation be made by a sword or bayonet, or if there be any prospect of healing by the first intention, the wound should be accurately closed by adhesive straps or by sutures. In sewing up an incised abdominal wound, many recommend that the needle should not pass deeper than the superficial cellular tissue—giving, as a reason, that when the muscles are included in the sutures they sometimes draw themselves out of the noose by their contraction, while, if the peritoneum be also included, peritonitis is likely to occur from the irritation of the thread. Although this may hold good in theory, it is not verified by experience. There is no reason why attempts should not be made to cause union throughout the entire thickness of the abdominal wall, and, therefore, all the tissues should be included in the suture. When this is done, the cicatrix will be firmer, and there will be less probability of secondary hernia—a very common accident after injury to the abdominal walls.

In probing abdominal wounds, the only object to be sought by the examination is, whether the wound has perforated the cavity or not? From the direction of the track, this can nearly always be determined. In this, as in any other gunshot wound, the use of the silver probe would be very dangerous, as it may convert a simple into a perforating wound. By means of the finger, or a gum bougie, the course of the wound can be traced, and also the existence of foreign bodies detected. Should we find that the opening transfixes the abdominal wall, our examination should go no

further. It is a dangerous amusement to satisfy curiosity at the expense of such irreparable mischief as may destroy the life of the patient.

If the wound be a large one, as when made by a bayonet, fragment of a shell, or minie ball, a portion of the abdominal contents may protrude from the wound. This is not a serious complication if the viscera be not injured. When the ambulance surgeon finds such a case on the field, his first duty will be to examine the protrusion. If it be a portion of small intestine, and be not injured, he cleanses it of dirt or other extraneous substances by pouring water upon it; and, carefully returning it within the abdomen, closes the wound by sutures, if it be an incised wound, or a broad strip of diachylon plaster, if a gunshot wound. He then administers a dose of morphine, and sees that the wounded man is properly transported to the field infirmary.

To facilitate the return of the protrusion, whether it be intestinal or omental, the patient is placed upon his back, with the thighs drawn up and the abdominal muscles relaxed, when the surgeon makes steady pressure upon the protrusion in the direction of the wound. The bowel must be handled very carefully—no force should be used, or so much injury might be inflicted as to cause the rupture, sloughing, or inflammation of the protruding organ. The better plan would be to encircle the protrusion by the fingers clustered together as a funnel or cone, which will diminish the bulk at the opening in the abdomen, and facilitate its return.

If it be found that the mass is so constricted, by the small size of the orifice, that the return within the abdominal cavity is impossible without inflicting injury upon the bowel, the intestine should be drawn to

one side, and, using great caution, the wound should be enlarged a quarter or half an inch, as the injury inflicted in the abdominal walls by the knife would be of small moment, when compared to the bruising of the protruding viscera from the force necessary to push it through the small opening.

Cutting upon a grooved director, or using a probe-pointed bistoury, while enlarging the wound, will diminish the dangers of injuring some important part within. The return of the bowel should always be effected by the ambulance surgeon before the case is transported to the field infirmary, inasmuch as the crowding of the wounded at the infirmary may be such, that several hours might elapse between the receipt of injury and the hospital examination—quite long enough to cause strangulation of the intestine, and sufficient to excite either inflammation or mortification of the protrusion, usually a fatal complication in abdominal wounds.

The early return of the protruding intestine makes the case one for simple and successful treatment. Be satisfied that the intestine has been returned within the abdominal cavity and not forced under the sheaths of the abdominal muscles, where it would strangulate and rapidly destroy life.

Should the case not be seen until several hours had elapsed, the intestine should be equally returned, whether it be blackened by congestion or be inflamed; but when gangrenous, which is recognized by its greenish ash color, loss of polish, its flaccid condition, with already a disposition to separation in its various coats, it should remain without the wound, and be laid open so as to allow its fecal contents to be evacuated. Adhesions rapidly form, uniting the protruded intestine to the peritoneum at the inner orifice of the wound.

This shuts off all connection with the peritoneal cavity, and prevents extravasation of fecal matter within it. If the bowel be returned in a mortified condition, the contents of the bowel would be discharged into the peritoneal cavity, and fatal peritonitis would be excited.

Should the intestine be punctured, it should be closed with one, two, or more points of interrupted suture, according to the size of the opening—a stitch being placed for every one-sixth of an inch of intestinal wound. The ends of the suture are cut off close to the knot, and the bowel is returned with care into the abdomen. A fine cambric needle will be the best instrument for sewing up intestinal wounds, as the small puncture and fine thread produce but little irritation.

It would be better to avoid perforating the mucus lining of the bowel in passing the sutures; but should the entire thickness of intestinal wall be transfixed by the needle, the pouting mucus surface must be pushed in from between the lips of the intestinal opening, so that, in drawing the noose of the suture, the peritoneal surfaces will be turned in and brought in contact upon each side of the wound, when rapid adhesion will take place. As the mucus surface is lined by an epithlium, its presence between the lips of the wound would prevent union. During the process of healing, an excess of lymph is deposited, which accumulates over the suture, incarcerating the knot. Finally the thread is thrown off into the bowel, having disengaged itself by ulcerating through the mucus membrane. This is a very beautiful provision of nature, for, should the thread escape into the peritoneal cavity, fatal inflammation would most probably ensue.

If a large dose of opium had been administered on the battle-field, or as soon as the patient had arrived

at the infirmary, while awaiting his turn to be dressed, the peristaltic action of the bowels would have been suspended, and the wounded portion of the bowel, which, when the hernia is extensive, should always be the last portion returned, remains within the abdominal cavity, in immediate contact with the wound; and to this point it soon becomes attached through adhesive inflammation. Should, from any cause, the sutures give way, or the bowel slough from the injury which it had received, its contents, instead of being thrown into the peritoneal cavity where it would produce fatal inflammation, would, on account of the adhesions of the bowel near an external outlet, escape externally, which diminishes materially the risk run by the patient. The threads used in closing the opening in the intestine, under these circumstances, either escape through the bowel by stool, or are discharged through the abdominal wound.

In examining the external wound when no protrusion exists, should we find an escape of fecal matter—which proves that the bowel has been perforated—some surgeons recommend that the abdominal wound be enlarged, and the wound in the intestine closed by suture. This they consider the only expedient for saving life—for, should the contents of the bowel be allowed to escape into the peritoneal cavity, a fatal issue must be expected. The dilatation of the wound, they believe, diminishes the risks.

In such cases I would prefer paralyzing the vermicular motions of the intestine by large and repeated doses of opium—the first dose being administered as soon as the condition of the wound is perceived, and the effects kept up for several days until the bowel becomes adherent to the abdominal wall, or the orifice in it becomes closed. With the cessation of peristaltic motion

the escape of intestinal contents will also cease, and the dangers of inflammation, from a foreign substance in the peritoneal cavity, diminish. Should the discharge continue, it would likely escape through the abdominal wound.

Should the intestine be extensively injured beyond the possibility of saving it, rather than return a portion of bowel within the abdomen to mortify and destroy the patient, it should be left hanging out of the wound. All of the sound portion of the protrusion having been returned, the crushed portion is enveloped in a wet or oiled cloth. The peritoneal coat of the bowel will form adhesions to the peritoneal edge of the abdominal wound, the outer portion sloughs, and an artificial anus forms, which gives constant escape to the fecal contents. In time this artificial outlet gradually closes by a spontaneous effort of nature, the feces seeking their normal passage. In nearly every case of artificial anus from gunshot wound, the restoration of the continuity of the bowel, with closure of the wound, is effected by nature, although the cure may be delayed for even twelve months. Rarely is it necessary to interfere, by an operation, to remove the deformity.

In examining the archives of surgery we find cases in which portions of the intestines have been cut off, the cylinder of the bowels reunited by sutures, and excellent recoveries obtained. These experiments have been tried successfully upon animals, and instances are met with where the human subject has been saved by a similar operation. I have recently had under my care a lunatic, who, some months since, attempted suicide by opening his abdomen, drawing out his bowels, and completely severing two feet of intestine. Dr. Gaston, of Columbia, S. C., who had the

case under charge, brought the two open ends of the intestine together, and, securing them by carefully-arranged sutures, returned them within the cavity. The patient made a perfect recovery. This accident, which terminated so successfully for the lunatic, suggests an operation for a crushed intestine, which may offer better prospects than leaving the bowel to slough and form an artificial anus. In such cases the best rule for treatment would consist in removing the injured portion, securing the bleeding vessels, and reclosing the intestine by sutures, and treating the case as if a simple incised wound of the bowel had alone existed.

In all perforating wounds of the abdomen, as we can not tell, in the absence of symptoms, whether the intestines have been injured or not, there are two fundamental rules of treatment never to be forgotten, and which are required in every instance.

1. Give opium freely and frequently, with the double object, viz: of controlling the peristaltic action, which alone can prevent extravasation of the contents into the peritoneal cavity, and for its antiphlogistic effect, to equalize the circulation, allay pain, suspend nervous irritability, and prevent inflammation.

2. Avoid the use of purgatives, and enforce abstemious or even absolute diet.

"In our hospital experience, gunshot wounds, implicating the intestines, give a mortality of about 25 per cent.,—the average duration of treatment for the successful cases being thirty-eight days. The large number, proportionably, of cures, depends upon the class of wounds, as many of the more serious die on the field before they could be conveyed to a general hospital."

Chisholm, [illegible]

When all perforating abdominal wounds, with injury to intestines, are included, the experience of field surgeons gives a mortality of 75 per cent. The formation of an artificial anus in the progress of the case should not be considered a serious complication, as they usually heal even when the bowel has been wounded in two or three places, with the formation of as many artificial ani.

With the majority of physicians, who have had but little experience in the treatment of abdominal wounds, the first impulse is to see the bowels emptied, and hence the fatal purgative is eagerly administered. An evacuation apparently reassures them that all is right; when, on the contrary, all is very wrong, as the progress of the case will soon show them. This is a fatal error, which the utmost after-care can not remedy. For three or four days at least after the receipt of injury, in which the intestines are known or are supposed to be wounded, absolute rest, the most abstemious diet, and the liberal use of opium (one grain of gum opium, or its equivalent in laudanum, every six hours), in connection with cold water or iced dressing, will compose the entire treatment. If the patient feels uneasy, an enema will relieve the large intestines and add much to his comfort. By the fourth day the wound in the intestines will have closed by lymphy effusion, and the dangers of exciting inflammation will, to a certain extent, have subsided.

If peritoneal inflammation be excited, with febrile reaction, pain greatly increased by pressure over the abdomen, and more particularly in the neighborhood of the wound, with tympanitis, vomiting, hiccup, small, quick pulse, and anxiety of countenance, the fears are that lymph and sero-purulent matter will be rapidly thrown out, gluing coils of intestines together

and filling the abdominal cavity with fluid. To check this rapidly fatal disorganization, leeches or cups should be applied to the abdomen, to be followed by hot narcotic or turpentine stupes, by blisters, or by ice bladders, which are now preferred, while opium should be given in large doses and at short intervals. If the patient be young and plethoric, and the inflammatory symptoms are early recognized, the lancet might be used; but as a rule, in military surgery, this remedy is badly borne, and has been generally discarded. Calomel was formerly used with the opium, and was considered the main dependence, but is now dispensed with, as all the advantages gained are accredited to the opium.

Sometimes in a few hours, usually at the end of the second or third day, collapse, with a cold, sweating skin, and feeble, irregular pulse, shows the ravages which the system has experienced from the peritoneal inflammation, and marks rapidly-approaching dissolution. It is rare that the liberal use of brandy, with carbonate of ammonia, external warmth, and sinapisms, rescue the patient at this advanced stage; although, if given when debility commences to show itself, they may support the patient, and be the means of saving life. When the swelling of the abdomen, and the dull sound which percussion elicits, shows extensive effusion, the abdominal wound should be reopened, and, by placing the patient in a proper position, the effusion be allowed to escape. It is a desperate operation, but has been known to save a few cases, which, if left alone, would have certainly perished, as those do upon whom this operation is not performed.

In gunshot wounds of the abdomen, if the missile has perforated, it would be madness to probe the abdominal cavity. We must imagine the worst, give

the patient the benefit of these doubts, and by extreme care hope to counteract the baneful influences which foreign bodies, when remaining in the abdominal cavity, always exercise. The ball may have traversed the cavity and embedded itself in the fleshy walls beyond, or even in the body of a vertebra, without having injured any organ of importance in its course. The absence of serious symptoms, as the case progresses, can alone inform us on this head. From the physiological effects following a gunshot wound we might, at times, trace the resting-place of the ball: *e. g.*, when paralysis of the lower limbs follows an abdominal gunshot wound, we might infer the burying of the ball in the vertebral column, with pressure upon the spinal cord, or an injury to the nerves of the extremity as they emerge from the spine, etc.

Should the abdominal wound bleed profusely, the source of blood may be from within the cavity, either from division of some large vessel or from injured viscera; or may be caused by the division of the epigastric artery while coursing in the abdominal walls. Should the orifice made by the ball lie directly over the course of this vessel, and external hemorrhage be excessive, the wound should be dilated, the bleeding orifices sought for, and, when found, ligated. When, from the former source, but little can be done, venesection to syncope might check the flow, and the formation of a clot may plug up the injured vessel. Some surgeons, knowing the desperate condition brought on by internal hemorrhage, recommend dilating the wound; and, should it be found that hemorrhage comes from one of the mesenteric vessels, the artery should be ligated. The position of the external wound

will assist us in forming a diagnosis as to the probable source of the hemorrhage. Cases of recovery are recorded where the wound was dilated, and the bleeding vessel in the omentum sought for and secured.

Where some of the large viscera or blood-vessels are injured in perforating abdominal wounds, the symptoms are much more marked than in intestinal wounds; hemorrhage at once takes place, to a serious and often fatal extent. Such wounded are often found dead upon the battle-field; or, should they be alive, they are pale and cold, with anxious countenances, and intense longing for water. This insatiable thirst is not peculiar to visceral wound or to nervous shock, but is an indication of serious hemorrhage. Should the wound be extensive, they never rally from this collapse. In other cases the shock may permit the clogging of injured blood-vessels, and may stop internal bleeding. Should life be prolonged until reaction takes place, the violent inflammation which is lit up, either from direct injury to the peritoneum or from the quantity of blood in the cavity, usually carries off the patient after a period of intense suffering.

On account of the hemorrhage and subsequent inflammation which accompany these injuries, all gunshot wounds of the larger abdominal viscera are considered nearly necessarily mortal, and exceptional cures are rare. Punctured wounds of the liver, stomach, or kidneys are often saved, and even gunshot wounds of these viscera are at times recovered from. When the external orifice is small, the position and direction of the wound will lead us to suspect the special injury, and, in connection with persistent vomiting, the ejection of blood by the mouth, by stool, or with the urine; the escape of special secretions, as

bile, urine, or feces by the wound; and the peculiar pain or sensations experienced by the patient—will be our chief indications in locating the injury.

In gunshot wounds of the stomach the contents escape externally, and also into the peritoneal cavity, where, as extraneous substances, they light up general and, usually, fatal peritonitis. As soldiers most frequently go into battle without previously having had a meal, the flaccid condition of the stomach, without contents to escape from this organ, is a great safeguard in case of wounds, and hence perforating wounds of this viscus more frequently recover under these circumstances than when gunshot injuries are received under other conditions. The location of the wound is often, in the army, the only basis for diagnosis, as the escape of contents and vomiting of blood are not constant symptoms, and shock, which is usually present, is common to all wounds of the abdominal viscera. When the patient survives the reactionary state from the effects of gunshot wounds of the liver, bile continues to flow from the wound, often in large quantity, the patient gradually becoming emaciated. He is rendered more feeble by diarrhœa, induced from the absence of the biliary secretion in the intestines, where its antiseptic properties are required to prevent decomposition of the injesta, and continued irritation. *In kidney wounds* the most fatal complication depends upon the infiltration of urine in the contiguous cellular tissue, creating extensive sloughs, poisoning the blood, and usually rapidly destroying life. Great pain in the lumbar region, frequent micturition, with bloody urine, retraction of the testicle, nausea, vomiting, indicate the injury. These cases usually do badly, and, in the experience of many army surgeons, are always fatal. We now and then hear of wounds

of the kidneys recovering, but their rarity only bring the fatal character of the lesion more prominently forward. If the exit for urine from the wound be free, then infiltration may not occur, and in these rare instances the size and location of the wound may be instrumental in effecting a cure. This is more especially the case where the injury is an oblique one, which has not implicated the abdomen.

The treatment of these serious wounds, which, on the whole, is so unsatisfactory, is similar to that required for perforating wounds of the chest, with injury to the lungs. Opium internally, and cold locally, with absolute diet, should become the basis of treatment. A little water or small pieces of ice is all that the patient requires during the first two or three days.

In *injuries to the bladder*, bloody urine, or rather the passage of clots as well as pure blood through the penis, is the diagnostic sign. Should urine escape from the wound, it is equally pathognomonic. In addition to the course already laid down for internal abdominal injuries, the introduction, by the penis, of a large gum catheter into the bladder, through which urine is allowed to drain away as fast as it is secreted, will assist in preventing urinous infiltration, which is one of the most fatal complications connected with a wounded bladder. The catheter should be introduced as soon as possible after the reception of the wound, and should be worn continuously for four or five days, until adhesive inflammation has closed the torn cellular tissue, and shut up the avenues into which the urine would have escaped. Should the injury be at the neck of the bladder, the catheter will also be required when the sloughs are separating, as swelling of the parts often obstructs the ready flow of urine. The gum catheter may even be

kept in from the commencement of the treatment until the wound is well advanced in healing, unless it excites much irritation, when it may be temporarily withdrawn. This precaution will prevent many cases of urinous infiltration, and save many lives.

Although this is clearly the course to be pursued, it is often impossible of attainment, as, even in the hands of a skilful manipulator, the instrument can not be introduced when the neck of the bladder, or the prostatic part of the urethra, has been divided. If the catheter can not be passed into the bladder a free incision should be made through the perineum for the evacuation of urine and the discharges from the wound.

The following case is pertinent to the subject, as it clearly demanded a perineal incision; the surgeon having failed to make it, nature in time effected it, but too late for the salvation of the patient.

Private T. Young, Company G, 7th New Hampshire regiment, was shot, on the 18th of July, at the assault upon Battery Wagner, Morris island. The ball entered the outer and posterior side of the left hip, about two inches below the great trochanter. Its range was slightly upward. Having passed under the skin of the perineum, cutting the urethra in the vicinity of its membraneous portion, the ball was deflected downward from its straight course, making its exit on the outer and posterior side of the right thigh, four inches below the great trochanter. When brought into hospital, the day after the assault, attempts were in vain made by the surgeon in attendance to introduce a catheter. Urine flowed from both wounds in the thighs, at first involuntarily. After a few days the patient gained control of his bladder, but could not direct the stream of urine, which still

flowed out of the thigh wounds whenever he mictu-rated. An abscess eventually formed in the perineum, which, when opened three weeks after the injury, also gave vent to urine. The patient died with extreme emaciation.

One of the chief points of interest in this case is the long track through which the urine found its way immediately after the injury, and by which it continued to escape. None was at any time passed through the penis, although the patient had a perfect control over the bladder.

Fortunate it is for men going into battle that the excitement under which the troops are at that time laboring causes a continual dropping from the ranks to urinate, so that rarely does a soldier go into battle with his bladder full. In this physiological fact lies the safety of many a man, as the contracted bladder, concealed behind the pubis, in the cavity of the pelvis, often escapes injury from the passage of a ball, which, were the organ distended, would assuredly traverse it.

Our hospital reports give several cases of vesical injury successfully treated. Among these is one of special interest, in which the ball, in traversing the pelvic region antero-posteriorly, transfixed bladder and rectum, anterior abdominal wall, and sacrum. Its extent was recognized by the escape of urine anteriorly, and urine with fecal matter through the sacral orifice, as well as urine running off by the rectum. In time these orifices closed, and the patient was discharged cured.

On May 5, 1863, I removed an encysted calculus from the bladder of Private R. S. Moore, Company E, Palmetto Sharp-shooters, who was shot at the Battle of Frazer's Farm, June 29, 1862. The ball passed obliquely, entering at the right side of the abdomen,

on a level with the crest of the pubic bone, crushing its outer surface, then traversing the bladder, and escaping through the left buttock, between the tuberosity of the ischium and base of coccyx. For several days after the injury the bladder emptied itself through both of these orifices, no urine escaping by the penis. After discharging urine for several weeks, the wound in the buttock closed, the abdominal wound continuing to discharge urine up to the day of operation for lithotomy—nearly eleven months. During this period he has passed by the penis pieces of bone as well as fragments of calculus. For four months he had been aware of the presence of a stone, which he felt rolling in his bladder. He had been confined to his bed for ten months, and was exceedingly emaciated, with hectic, when he presented himself for operation. So direct was the communication of the anterior fistula with the bladder; that, when this viscus was injected, prior to the operation, the water escaped so rapidly from the fistula as to empty the bladder before it could be opened. A round stone an inch in diameter was found encysted over the pubic region, and was removed with much difficulty. The case recovered very rapidly. The abdominal opening closed up at once, no urine escaping from it after the operation. The nucleus of the calculus was paste-like, with no trace of a foreign body which I expected to find. Among the many points of interest which the case possesses, is the one of the orifice of exit healing first, although urine was discharged through it as the most dependent orifice.

Injury to the large intestines, when not involving the peritoneal cavity, are not so serious as perforations of the small. As the large bowel is bound down in the greater part of its course, extravasations of their contents do not necessarily take place into the abdominal

cavity; and although fecal matter escapes externally from the wound, and high inflammation, with profuse suppuration, usually follows, many of the wounded eventually do well.

Cases not unusually occur on the battle-field in which the abdominal contents might be severely crushed without apparent external injury. It is the toughness and elasticity of the skin which gives rise to the exploded theory of the wind of a ball destroying life; and such cases as those we are now considering were formerly brought forward as instances of the fatal effects of the vacuum following the wake of a cannon-ball.

Observation has shown that a knapsack might be torn from the back, a hat struck from the head, an epaulet from the shoulder, or a pipe from the mouth, without leaving a trace of injury; while, on the other hand, viscera might be reduced to a jelly, or bones crushed, without a visible bruising of the skin. It is the ball itself, and not the wind, which produces these disorganizations. From the blow of a spent cannon-ball or fragment of a shell the liver might be lacerated, intestines torn, blood-vessels opened, spleen fissured, or kidney ruptured, without an external wound. Severe shock and collapse mark the extent of injury received; and should the patient rally from this condition, which is rare, violent inflammation will soon destroy life. Although we follow vigorously the treatment laid down above, we very seldom have the satisfaction of saving a patient.

Sergeant E. L. Davis, Company C, 7th battalion S. C. V., was injured, on the 10th of July, during the bombardment of Battery Wagner, by the explosion of a shell. Two days afterward, when he entered the general hospital, he complained of pain in the left lumbar

region, where he had been struck. There was no eschimosis present. although there existed some tumefaction—not, however, sufficient to excite any apprehension. There was slight abrasion about his face and right side. Six days after the injury, he having suffered much with pain, fluctuation was detected in the lumbar region. A puncture was made, which discharged a large quantity of pus, and, with it, fecal matter. Some of this escaping into the cellular tissue of the loin and buttock induced a phlegmonous condition, with rapid sloughing of cellular tissue. Although free incisions were made, the sloughing could not be checked. It extended in every direction, until one vast sloughing cavity occupied half the trunk, from the ribs to the trochanter, and from the vertebral column to the pubis. An autopsy revealed a double rupture in the descending colon, with openings parallel to the circular fibres, which had permitted the free escape of fecal matter into the cellular tissue, between the bowel and quadratus lumborum muscle. Collecting in quantity, it had separated and disorganized the tissues as low as Poussart's ligament, forming a large sac distinct from the peritoneal cavity, and separated from it only by the peritoneum. In this the iliac artery was lying bare. Had the feces not escaped in the loin it would have dissected to the groin, as the fecal cavity was bounded below by Poussart's ligament.

The amount of destruction effected by a spent ball is often surprising. The uninitiated on the battle-field will attempt to stop, with the foot, a cannon-ball rolling on the ground, and which is just about exhausting its force, perhaps with only momentum sufficient to carry it one or two feet further, yet it crushes the limb put out to oppose it. Baudens, in warning persons to avoid cannon-balls, however slowly they may be

rolling, mentions the case of a grenadier of the guard, sleeping on his side on the ground, who was instantly killed by a spent cannon-ball, the blow from which luxated the vertebral column. The ball came with so little momentum that it rolled itself up in the hood of the soldier's overcoat, where it was found. It was just about to stop when it struck. One or two feet further, and its entire force would have been exhausted.

Balls nearly spent, in perforating the pelvic cavity, expend all of their force in passing through the bones, and then remain embedded in the cellular tissue. As such wounds do not readily heal, on account of spiculæ of bone keeping up a discharge, a probe can be passed through the orifice in the bone to the ball beyond it. In the case of Private E. J. Matthews, of the 26th Alabama regiment, a youth of fourteen years, who, when returning from a fifth charge against a Yankee battery during one of the Battles of Richmond, was shot in the back; the ball entered through the sacrum an inch from its spinous processes, and one inch below the level of the crest of the ilium. Eight months after the reception of the wound he applied to me for relief, as he had a constant discharge of pus from both the wound in the back and a fistulous passage in the left groin. Upon examination with a probe, which passed in four inches, traversing the sacrum, the foreign body was detected, the bulb of the probe entering the cup of the minie ball. By using a gouge, the orifice through the sacrum was enlarged sufficiently to allow the ball being drawn from the pelvic cavity. The case recovered.

CHAPTER XII.

INJURIES OF THE EXTREMITIES—COMPOUND FRACTURES—DIFFERENCE OF TREATMENT IN THE UPPER AND LOWER LIMBS—IMPORTANCE OF AN EARLY EXAMINATION AND ADOPTION OF A COURSE OF TREATMENT WITHIN TWENTY-FOUR HOURS AFTER THE RECEIPT OF ACCIDENT—COMPOUND FRACTURES OF THE ARM FROM SHOT WOUNDS, WHEN NOT IMPLICATING JOINTS, DO NOT REQUIRE AMPUTATION; SHOULD THE BLOOD-VESSELS AND NERVES BE CRUSHED WITH THE BONE, THEN AMPUTATION NECESSARY—WHEN GUNSHOT FRACTURES IMPLICATE JOINTS, RESECTION OR AMPUTATION IS THE BEST MEANS OF SAVING LIFE—HOW RESECTIONS ARE TO BE PERFORMED—SPECIAL RESECTIONS OF SHOULDER, ELBOW, WRIST—RESECTIONS AND AMPUTATIONS OF THE INFERIOR EXTREMITY—PRIMARY AND CONSECUTIVE AMPUTATION—WHEN, AND UNDER WHAT CIRCUMSTANCES, AMPUTATIONS SHOULD BE PERFORMED—MODES OF OPERATING AND OF DRESSING STUMPS.

As the major portion of the injuries of the extremities are merely flesh wounds, these will not require to be now noticed, but the effects of such wounds in impairing the uses of a limb will be hereafter considered. Those which we will now discuss are such as involve the bones, joints, or important vessels, and which may call for special treatment. It is in this department that conservative surgery has made the greatest advances, and has accomplished so much in diminishing mortality and mutilation. Not that amputations will ever be abolished, for many lives can be saved in no other way than by the sacrifice of limbs; but conservative surgery has shown that the constant flourish of the amputating knife is not the way to obtain the greatest number of surgical victories in times of war. Amputations must, however, ever remain a surgical

necessity; and he who removes crushed limbs with the greatest skill, and saves the patient by successful after-treatment, will ever deserve the high position which humanity and philanthropy will bestow upon him.

In gunshot wounds of the extremities we find a much greater vitality and resistance to injuries in the upper than in the lower limbs, which would modify the treatment of similar injuries located in these two portions of the body. This depends upon the greater vascularity and freer anastomosis in the arm than in the leg. In the more liberal supply of blood-vessels and nerves we find the source of safety which enables us to save an arm, when, for a similar injury, a leg would be generally condemned.

The most common accidents to the extremities which give surgeons the greatest annoyance, and require the most careful diagnosis, prognosis, and treatment, are *compound fractures*. These have always made a numerous and important class in military surgery, but have become doubly so in modern warfare, from the substitution of conical shot for the round musket-ball. This projectile seldom impinges upon a bone without leaving frightful traces of devastation. Such a conical ball rarely remains embedded, but, acting on the principle of a wedge, splits and comminutes the bone, driving the loose spiculæ in every direction before it.

When a bone is crushed by a ball, the patient is conveyed very carefully to the field infirmary; or, if it can be done without delay, to the general hospital, where the treatment commences. On the field the ambulance surgeon can do nothing but administer a dose of morphine, and secure the limb to a rough splint, to facilitate transportation. For a fractured

clavicle, scapula, or humerus, the arm is bandaged to the chest, which, on the battle-field, answers the purpose of a temporary splint; for a crushing of the forearm or hand, the arm is laid upon a board splint, and slung from the neck. If the splint is not at hand, the sling made of a handkerchief must answer until the wounded man can be better attended to—it being understood that a wet or greased cloth is always put over the wound for its protection during the transportation.

When he arrives at the hospital the limb is carefully examined. The external wound may give no indication of the extent of internal injury. When the finger is introduced and the wound carefully explored, the degree of crushing will be ascertained, and the question at once proposes itself: what course shall we pursue? Shall we attempt to save the limb; or does its condition, with the want of proper facilities for its successful treatment, necessitate its condemnation? If we have had experience in the care of gunshot fractures, we should anticipate the dangers, and, with Sir Charles Bell, contemplate what will be the condition of the parts in thirty-six hours, in twelve days, or in three months. In thirty-six hours the inflammation, pain, and tension of the whole limb, the anxious countenance, the brilliant eye, the sleepless and restless condition, declare the impression the injury is making on the limb and on the constitutional powers. In twelve days the affected limb is swollen to sometimes half the size of the body; a violent phlegmonous inflammation may pervade the whole; serous effusion has taken place in the limb, and abscesses are forming in the great beds of cellular texture through which the ball has passed; from the wound pus is escaping in large quantities, impoverishing the

blood, and rendering the system irritable. In three months, if the patient has labored through this lengthened agony, the bones are carious; the abscesses are interminable sinuses, from which are kept up a continued discharge; the patient is pale and emaciated, with hectic flushes and diarrhœa, and the constitutional strength ebbs to the lowest degree. All these conditions must be rapidly considered, and with them the more immediate dangers of mortification, and the remote dangers of erysipelas, pyæmia, and hectic, and the questionable utility of the limb, when, after several months of continued trials, the wound has been healed, but the limb remains weak, shrunken, stiff, painful, and nearly useless.

Our conclusions must be made and acted upon within twenty-four hours, or before reaction sets in, while the patient has his sensibilities depressed by the shock. Success of treatment depends upon prompt action—the delay of a few days has destroyed thousands of wounded. Should amputation be required, there is no period in the progress of the case so favorable for the performance of this operation as the first four-and-twenty hours. Should an injudicious attempt be made to save the limb, until suppurative action has been well established an amputation can not be resorted to with as good prospects of success as prior to the development of the inflammatory stage. Should erysipelas attack the wound, an amputation is impracticable; and when gangrene has supervened, during the stage of reactionary excitement, we are driven to an operation under the most unfavorable circumstances.

Consolidated Table of Amputations, from June 1, 1862, to February 1, 1864, collated from reports in the Surgeon-General's office.

	Primary.				Secondary.			
	Cases.	Cures.	Deaths.	Per cent.	Cases.	Cures.	Deaths.	Per cent.
Thigh	345	213	132	38	162	43	119	73
Leg	314	219	95	30	150	76	74	49
Arm	294	252	42	14	140	87	53	37
Forearm	69	61	8	12	45	35	10	22
Shoulder-joint	79	54	25	31	28	8	20	71
Elbow-joint	4	3	1	25	3	2	1	...
Wrist-joint	7	5	2	28	...	...	...	...
Hip-joint	3	1	2	66	...	...	...	...
Knee-joint	5	2	3	60	6	...	6	100
Ankle-joint	6	4	2	33	4	4	...	...
Tarsal-joint	16	13	3	19	8	7	1	12
Total	1,149	827	315	27	546	262	284	51

The report of a much larger number of amputations have been received at the Surgeon-General's office, but as the results of treatment in many cases have not been given, these doubtful successes have been purposely omitted from this table.

There are numerous compound fractures upon which judgment can be immediately passed: with some, there is every probability that the limb can be saved; while there are others in which the limb is condemned at a glance—our prognosis being based upon the following circumstances: As the upper extremity can sustain a much more serious injury than the lower, we may lay it down as a rule that a compound fracture of any of the long bones of the arm, when not complicated with excessive crushing of the soft parts, or injury to blood-vessels and nerves, *can and should be saved.* An arm is rarely to be amputated for recent gunshot injuries, except from the effects of balls breaking up

extensively the shaft, with long fissures extending into joints, or where cannon-shot or fragments of shell, besides crushing the bones, makes frightful lacerations of the soft tissues, tearing away muscles, nerves, and blood-vessels, and even at times carrying off the limb—the surgeon's services being required only to give a better form to the stump.

For a gunshot wound from a musket or minie ball, which has fractured the bones of the arm without implicating a joint, the following is the course to be pursued: At the field infirmary the wound is carefully probed with the finger, and its spiculated condition noted. *All loose fragments are to be removed at this first examination, before reaction ensues*, for it will be very injurious to the wound, as well as excessively painful to the soldier, to continue such examinations from day to day. The first examination should always be effectual. The patient is then suffering from shock, with sensibility temporarily blunted, and is, therefore, in the best condition to be operated upon. To render this first examination complete, should the shock have passed off and the patient complain of much pain, it would be better to give him large doses of opium, or administer chloroform, rather than desist from this important portion of the treatment. Make a thorough exploration with the finger passed into both orifices, and should the bone be found much crushed, and the orifices made by the ball not sufficiently large to permit of their easy extraction, dilate the opening and remove all detached fragments. Should we omit to bring away all spiculæ, the further removal should not be attempted during the stage of excitement and febrile reaction, which will come on after twenty-four hours, and which will run its course in six or eight days. When this subsides, then, and

not before, we make the second examination, and, by the use of instruments, remove any loose fragment which we may now detect. We will simply mention, in this connection, that as there is not the slightest probability, or even possibility, of the wound closing by the first intention, the insertion of tents and pieces of lint is a relic of barbarous surgery, which being useless, injurious, and very painful, can not be too severely condemned.

Modern surgery recommends that all spiculæ, whether detached or not, should be removed, but this practice, unfortunately, is not carried out by surgeons generally; and, as the result of this negligence, our country and hospitals are filled with cases of necrosis of one and two years' standing—men who add materially to the numbers and expense of an army, without in any way increasing its efficiency. Experience and observation has, in a few instances, shown that, although large fragments may be detached from the shaft of the bone, they may still be adherent to the periosteum, which may effect a reunion and consolidation. On the other hand, experience and observation continually show that, from the force with which conical shot strike a bone, the spiculæ, which may be very numerous, are driven in every direction, but generally toward the opening of escape of the ball. At other times the bone is broken in larger pieces and is split, fissures extending upon the shaft for some distance, even perhaps to the adjacent articulation. These sharp splinters can not but produce excessive irritation in the soft parts, and may, by transfixing vessels, pricking nerves, or irritating muscles, induce hemorrhage, mortification, or tetanus. Or inflammation of the lining membrane and periostial envelope, with profuse discharge, may entail rapid prostration and intense

suffering. No surgeon doubts the propriety of removing all such fragments on the spot, or at the earliest possible moment. As the opening of exit, around which the larger number of the fragments are found, may be too contracted to admit of a thorough exploration of the wound, it will not increase the dangers, but, on the contrary, materially diminish the risks of after-trouble, if the wound of exit, in compound fractures with crushing of the bone, be dilated, so as to facilitate the detection and removal of every spiculæ. In enlarging this orifice, injury to the important blood-vessels and nerves will, of course, be avoided by incising parallel to the axis of the limb.

On the subject of removing *all* fragments, whether detached or not, there appears to be no longer a diversity of opinion. The older surgeons, who base their treatment on the effects of round balls, believe that often the connection of the fragments to the soft parts and to the periosteum will guarantee a consolidation of the fragments. The round ball simply breaks the bone without usually scattering the fragments, and, therefore, their relations to the surrounding tissues will not be so materially changed. But, notwithstanding this impression, which may or may not be correct, what does actual experience prove, when reduced to facts?

Take the experience given by the inmates of the *Hotel des Invalides*, as recorded by M. Hutin, the surgeon of the institution. He states that those spiculæ which had been attached to the soft parts, and which were allowed to remain in the hope of reunion, although they may not give trouble at the moment, invariably end by becoming sequestra, and, after a long period of pain and suppuration, demand removal. He reports several hundred cases in which the retained

fragments, sooner or later, set up an eliminative action, which is always painful, often dangerous, and at times fatal. M. Hutin refers chiefly to the effects of round or musket balls. Baudens gives, as his Crimean experience, "That whether adherent or not, it is better to remove all spiculæ, and thus simplify the wound. If these be retained, endless suppuration, continued suffering, with exacerbations of all the symptoms at the escape of each small fragment, will gradually exhaust the vital forces, and entail its sequelæ of marasmus, diarrhœa, and hectic." Suppuration will eventually bring all of the fragments to the surface, but at what a sacrifice!

McLeod, after quoting the experience of Roux, Baudens, Guthrie, Hutin, Dupuytren, Curling, Begin, and others, on the dangers of allowing movable fragments to remain, and the necessity of extracting every piece which is not extensively attached to the soft parts, gives his experience as decidedly in favor of the modern practice of removing *all movable spiculæ* as the best mode of hastening a cure and diminishing mortality, "As the removal must tend immensely to simplify the wound."

Again, he says: "The extensive comminution of the bone by a conical ball makes the indications with regard to the management of the sequestra more evident than it is commonly considered. I do not think that we paid sufficient attention to their removal in the East. It may be true, as some tell us, that in fractures with the old ball it was desirable to meddle as little as possible with the fragments; but this is the teaching of only a few. However, to my mind, the question assumes a totally different light when viewed by the pathological results which we had occasion to witness."

Some surgeons go further, and recommend that not only should all spiculæ be removed, but that the sharp, irregular ends of the bones should be sawed off. This suggestion has not met with general approval, and is spoken of by Stromyer and Loeffler as no improvement. Their experience gave a larger mortuary list when this practice was attempted.

There is no doubt that the *removal of all fragments* will expedite the cure. In surgery, whenever we are in doubt, we should always give the patient the benefit of it; and in the subject under consideration, knowing that the removal of the attached fragments, which might eventually become consolidated, can do no harm, while leaving them in, should union not be obtained, would not only be followed by serious danger, much annoyance, and suffering, but would eventually require removal, we should, without hesitation, give the patient the benefit of the doubt, and remove all of them at the first examination.

If a compound comminuted fracture from a gunshot wound be examined three weeks after its occurrence, it will be found that the limb will always be enlarged, the tissues œdematous, the muscles softened, orifices pouting, from which laudible pus in quantity is daily discharged, and at the bottom of the wound the probe comes in contact with denuded pieces of bone, which appear movable and isolated as if in a pouch. If an incision is made so as to expose the injured bone, a cavity will be entered, lined with a granulating pus-secreting surface, in which the broken pieces of bone lie denuded of their periosteum, isolated from all connection with the soft parts, and perfectly bleached as if they had undergone a long process of maceration. Some fragments which still remain connected with the soft surrounding tissues will be blanched upon

their free side. The periosteum which attaches them to the contiguous tissues is soft, thick, and very vascular, adhering closely to an intermediary substance of spongy texture—evidently new bone in process of formation. In other fragments this new deposit from the thickened periosteum has so nearly enveloped the piece of bone broken from the shaft, that the partially isolated white bone can not be separated without breaking through this newly-formed shell. The white fragments are those pieces which had become isolated from the soft parts by the force of the projectile, and, as is always the case, have been killed, as it were, from that moment and until removed, either slowly by nature, or by a surgeon, irritate the soft parts as foreign bodies, and excite the copious discharge of pus from the wounds.

The incarcerated fragments are such as were still adhering to the soft parts by their periostial surface, but had met with such destruction of their interstitial nutrient vessels, by the abrupture of the shaft and the tearing of the medullary membrane, as to be incapable of living. They remain adherent only for a time; new bone is formed over them; gradually they are isolated from the new structure and form, as do the movable fragments, sequestra. From these pathological developments it would appear that the detached fragments are at once destroyed, and those still connected to the soft parts have their nutrition so impaired that they also die and become foreign bodies.

The course of treatment based upon pathology is, then, clearly defined. If the chief cause of death in compound gunshot fractures is from irritation of the system, and from the profuse discharge of pus draining off the life's blood, both of which are caused by these foreign bodies, the army surgeon is culpable

who attempts to treat a compound fracture without removing all such fragments of bone broken off from the shaft by the ball in its passage, whether they are loose or not. Besides the immense number of victims which the grave conceals, the number of necrosed limbs daily appearing before our examining boards for furloughs and discharges show sufficiently the neglect of this principle. The country is now filled with men upon whose arms and legs suppurating fistulæ lead to exfoliated fragments, incarcerated in a shell of new bone, or embedded in the soft parts, and which years of suffering and annoyance have not been able to eliminate. These living testimonials of a bad practice establish a rule of treatment which we should never swerve from except when it is impossible of performance, viz: *in gunshot fracture of the long bones remove, without fail, and as soon after the accident as possible, all fragments of bone.* Experience shows that, where this course is rigorously pursued, the duration of treatment is very much shortened, and the mortality decidedly diminished. Our marked success in the treatment of compound fracture, as shown by the reports from the Surgeon-General's office, can be attributed, in a measure, to the general adoption of this rule of practice.

While recommending so urgently that all fragments be removed, I am averse to the operation of cutting off the sharp ends of fractured bones, as these, not having their circulation materially disturbed, are not liable to the same dangers of necrosis as are the fragments. Their nutrition is well supported, and such ends usually consolidate. Even when the periosteum has been stripped from the ends for some distance, destruction does not necessarily follow—as the bone, through its immediate vascularity, may become soft-

ened, its blood-vessels enlarged, and granulations for the formation of new bone appear upon and cover the surface.

Feeling secure that we have removed every foreign body, and having left nothing in the wound which is likely to retard the cure, we should ignore the presence of the wound as much as possible, and treat the case as one of simple fracture. Inflammation and suppuration we expect; they generally accompany compound fractures, and especially those connected with gunshot wounds; and remembering the long-continued and profuse drain which will establish itself after four or five days, we should be careful how we make use of active antiphlogistic treatment. For the first week or ten days the limb may be stretched upon a pillow, or loosely secured to a broad, long splint, which will support the entire extremity, and prevent all movements between the broken ends. During this period we confine the treatment to cold water dressings, either by iced bladders, applied over compresses, in order to remove the injurious effects of its direct application, or by the process of irrigation—either of which, when judiciously applied, is better than the continued renewal of wet cloths.

When we speak of the advantages of irrigation above all other methods of treatment for keeping down inflammatory action, we do not refer to the abusive mode of application common in the army, of deluging the body and bedclothing of the patient, and keeping him for days in this saturated state, frequently chilled by the evaporation going on from the entire surface of his body, whenever the bedclothes are thrown from his person. Under this process we have not been surprised to hear surgeons complain that pneumonia has frequently developed in the

course of treatment, and that erysipelas is more liable to appear in such patients. All the good effects are only obtained when the water dressing is strictly confined to the vicinity of the wound.

The general treatment, for the first few days, or during this period of inflammatory excitement, consists of simple diet, rest, quiet, and the administration of mild diaphoretics, with the liberal use of opium. Pain we do not consider, in any sense, necessary to the healing of wounds, and, therefore, have always made it a rule in practice to reduce it to its minimum. The complete annihilation of pain will neither detract from the rapidity of healing, nor from the gratitude of patients. The impropriety of active cathartics will be at once evident from the movements made necessary by their action. Bloodletting, emetics, and the use of mercury we absolutely discard, as always useless and injurious in the treatment of any stage of compound fractures. As soon as the period of inflammatory reaction has subsided, we then apply such splints and bandages to the limb as will secure quiet and rest, while at the same time a free vent is allowed in the apparatus for the escape of discharges from the wound. This opening also permits the application of water dressings to the wound.

The most dangerous fractures of the extremities are those extending into a joint, and involving the heads of the bones. The synovial injury adds greatly to the danger of the case, and in former times was considered nearly a fatal complication, as it necessitated an amputation which, under the ordinary circumstances attending hospital treatment, was not far removed from a fatal termination.

The severity of the symptoms of articular injuries depends upon the size of the joint and the character

of the wound. The dangers are, at times, serious enough with even the smallest puncture, but when the wound is large and lacerated, and often even when it is apparently trifling, extensive local mischief and constitutional disturbance ensues, leading with certainty to the destruction of the joint, and usually destroying the patient. Hence, in the days of John Bell, the united experience of surgeons considered wounds of joints mortal. Crimean experience corroborates John Bell's conclusions, as no serious injury to the large joints recovered unless the limbs were amputated or joints resected. The great danger is not in the serious injuries, as these cases are at once operated upon. It is in the apparently trivial case, where, from the very small size of the wound, we hope that no trouble will supervene, that violent inflammation shows itself, and life is sacrificed.

The cold water treatment of wounds, so universally adopted in the Confederate army, both in field and hospital practice, shows its great advantages over every other dressing, even in this hitherto fatal class of injuries. In examining the reports in the Surgeon-General's office we find that a fair proportion of gun-shot wounds of joints have recovered, where no operation was attempted. In knee-joint injuries, which, when not operated upon, have heretofore been considered as always fatal, we can show nearly fifty per cent. of cures. Quiet, rest, immobility of the injured joint, cold water dressing by irrigation preferred, and opium, comprise the elements of successful treatment.

Consolidated Table of Injuries of Joints, treated without Amputation, made up from records in Surgeon-General's office, from June 1, 1862, to February 1, 1864—prepared by Surgeon H. Baer.

	Shoulder.	Elbow.	Wrist.	Hip.	Knee.	Ankles.	Remarks.
Cases of gunshot injury.....	17	55	28	8	103	29	Of these 7 recovered with serviceable limbs, and 45 with anchylosed joints; remainder not stated.
Recoveries.........................	11	50	26	...	50	23	
Anchylosis.........................	3	22	7	...	21	1	
Serviceable limb	...	4	1	...	2	...	
Deaths...............................	6	5	2	8	53	6	
Percentage of mortality.....	35	09	07	100	51	20	
Average period of death.....	19	39	35	60	40	27	Days.
Greatest " " "	39	59	35	119	163	44	"
Least " " "	9	6	35	18	15	16	"
Average period of recovery	132	101	95	...	166	71	"
Greatest " " "	264	270	240	...	285	110	"
Least " " "	32	28	45	...	96	43	"

In comparing the table of injured joints not operated upon with the table of resections, it must be remembered that the more serious cases were operated upon. If these had been treated without resection or amputation, the mortality among such would have been very heavy. In many of the cases above reported, the joint was simply opened without injury to the bones, while in all cases of resection balls had entered the joint, tearing up the capsule and, in most instances, crushing the articulating surfaces, and, therefore, making the prognosis much more serious.

A wounded joint, under the ordinary hospital treatment, will exhibit the following symptoms: When a ball has perforated the joint, the period of reaction is not long absent. In extensive wounds a great degree of nervous shock accompanies the injury, the patient lying deadly pale, cold, and faint. In from twenty-four to forty-eight hours the tissues around the articulation become hot, swollen, and painful; inflammation has already seized upon the synovial membrane, and will soon involve all the structures. All these symptoms

rapidly increase until they become excessive. There is no rest for the weary sufferer, who, often in spite of iced applications and the free use of morphine, with the entire arcana of antiphlogistic remedies, writhes about in unmitigated agony. If the aperture leading into the joint be made by a ball or piece of shell, the synovia at first, and in two or three days pus, freely escapes. Should the entrance into the joint be small, or the passage oblique, the purulent synovia fills and distends the joint, adding much to the pain, which is increased by the irregular spasmodic contractions of the surrounding muscles.

Accompanying these local symptoms will be found a high grade of inflammatory fever, with rigors, great gastric distress, intense thirst, excessive restlessness, and with such an amount of constitutional disturbance as sometimes to destroy life in a few days. As the disease advances, abscesses form in the surrounding tissues by extension of the inflammatory process, and in a few days open continuous passages to the joint, from which a constant discharge of purulent matter escapes. Should the patient have an iron constitution, and the case terminates successfully, it will only be at the expense of time. After many weeks, or even months of suffering, emaciation, and hectic, the discharge will gradually cease; but as the preceding inflammation has destroyed the cartilaginous surfaces of the joints, and also the character of the synovial membrane, lymphy deposits will so mat the extremities of the bones together as to permit of but little motion, and an interstitial deposit in the tissues surrounding the articulation will restrain all motions of the tendons and muscles passing in this neighborhood, anchylosis being the usual sequelæ of a suppurating joint. In some cases, where mechanical means are

used to break up these bands as soon as the inflammatory stage has passed, movable joints have been saved; as a rule, however, a stiff joint follows articular injury.

If the patient be not destroyed in the early stages of the disease by nervous exhaustion from the intense and constant pain, or by erysipelas and pyæmia, in connection with the irritative fever to which such joint wounds are particularly liable, he falls a prey to hectic, caused by the continued drain from the disorganized joint—synovial membrane, cartilages, and bones forming one mass of disease. In severe gunshot wounds of large joints, in military hospitals, rarely does the patient escape with life. In private practice he sometimes recovers, but even under the most advantageous circumstances for treatment a successful case is rarely seen, and then usually with a destroyed and anchylosed articulation. As the results in injured joints are so fatal, surgeons had, at an early day, adopted amputations as giving the only chance for recovery. In recent years conservative surgery has introduced the operation of resection as affording not only the means of preserving life, but also of saving a useful limb.

The diagnosis of articular injury is usually evident from the direction of the wound and from the escape of synovia; at times, however, when the orifice is small and the wound circuitous, a successful diagnosis requires much experience and close observation. When possible, a consultation should always be had over these cases; as it is often in these very cases of apparently trivial injury that the most violent reactionary symptoms are met with, and that a fatal issue occurs. If left unoperated upon, the apparently trifling wound, perforating the joint, might lead to severe crushing

of the bones, which, if left unrecognized, might nearly be considered mortal; while, if the joint be not implicated, the operation of resection is not only not called for, but unnecessarily risks the life of the individual. The urgent necessity for an accurate diagnosis is evident.

For injury to the heads of bones forming the joints in the upper extremity resection is particularly applicable, and this operation is now the rule of practice, having superseded amputation in all cases where the blood-vessels and nerves around the joint are not involved in the injury. When a joint has in any way been injured by a gunshot wound, whether the joint has been largely opened, or the heads of the bones forming the articulation crushed, as soon as the excessive shock under which the patient may be suffering passes off, we proceed at once to operate. A primary resection is as much called for as a primary amputation, and is followed by as successful results. It should be performed within twenty-four or thirty-six hours, or before reaction sets in. Such cases would do much better if the patient could be transferred to the general hospital prior to an operation, as transportation is difficult and dangerous immediately after the resection, from the difficulty of securing the limb from movements. Experience has so established this fact that, in cases necessitating a long and tedious transportation, the rule is to amputate rather than to resect, inasmuch as the gravity of the resection is very much increased by the transportation. Should the case not come under observation until reaction has set in, then, by general, mild, antiphlogistic treatment, and ice bladders or cold water dressings locally, we await the establishment of suppuration—after which

the operation might be attempted with good prospects of success.

The results of the primary resection are more successful than the secondary; and these are, in turn, much more likely to succeed than when the operation is performed during the stage of febrile excitement.

There are three or four rules necessary in all cases of resection, and which should not be forgotten during the operation, viz: Make the incisions for exposing the heads of the bones in that portion of the extremity opposite to the main blood-vessels and nerves, so that these may not be exposed to injury. If possible, make the existing wound lie in the line of operations, and place the incisions in such a way as to permit a continued drain from the joint. Make these incisions free, so as not to cramp the operator in turning out the heads of the bones. An inch added to the incision does not increase its serious character, and hastens the operation. Remove most of the synovial membrane, and save as much periosteum as possible; the one is prone to take on inflammation—the other makes, and will, to a certain extent, reproduce the bone. In performing secondary resections, the removal of all the diseased synovial membrane becomes one of the first elements for success.

More successes are obtained from resections of the shoulder-joint than from an operation upon any other articulation—the statistical tables of the final results of operations in favor of resection being conclusive over amputations.

In examining these tables take into consideration that primary operations are performed upon the most serious injuries; the cases of apparently trivial injury are kept, and resection found necessary during the progress of the case.

Consolidated Table of Resections, collated from records in the Surgeon-General's office, from June 1, 1862, to February 1, 1864—prepared by Surgeon H. Baer, P. A. C. S.

	Shoulder.	Elbow.	Wrist.	Hip.	Knee.	Total.
PRIMARY.						
Successful	28	22	2	..	..	52
Unsuccessful	13	3	..	..	2	18
SECONDARY.						
Successful	20	23	1	1	1	46
Unsuccessful	7	6	..	1	1	15
USEFUL JOINTS	2	7	..	..	..	9
Total	68	54	3	2	4	~~131~~ 140

Consolidated Table of Disarticulations, made up from records in the Surgeon-General's office, from June 1, 1862, to February 1, 1864—prepared by Surgeon H. Baer.

	Shoulder.	Elbow.	Wrist.	Hip.	Knee.	Total.
PRIMARY.						
Cures	54	3	5	1	2	65
Deaths	25	1	2	2	3	33
SECONDARY.						
Cures	9	2	..	..	..	11
Deaths	20	1	..	..	6	27
Total*	108	7	7	3	11	136

* Sixty-five additional cases had been reported, but, as the results had not been determined, they have been omitted from this table.

When the ball has entered directly within a joint, only the surface may require excision; but should the head of the bone be extensively spiculated, we must

cut back to the sound bone, even if we are compelled to remove four or five inches of the shaft of a bone, as was successfully done first by Stromyer for a gunshot injury, and several times in the Confederate service. Should the receiving cavity be equally injured, the fractured portion should be removed. The rule is, never to remove more of the bone than is absolutely called for, and not to open the medullary cavity if it can in any way be avoided.

When the wound has been cleansed of all foreign bodies, the flap is replaced and secured with one or two points of suture. As adhesion by the first intention is not usually expected, and gives no advantage over the final result by granulation, nice adjustment along the entire line of the incision is not necessary. An opening must be left at the most dependent portion of the wound for drainage. The patient is then put to bed, and cold water dressings applied. Inflammation at first runs high, the parts around the joint are much swollen, and a collection soon forms within the cavity from which the bones have been removed. The escape of this decomposed blood and pus from the wound gives great relief. When kept in by the too nice adjustment of the flap, the collection increases the swelling, œdema, and pain, which is diffused over the neighboring parts, involving the chest as well as arm. When suppuration becomes established the swelling and pain subside, granulations spring up, and eventually close the wound. In the meantime, the divided muscles have formed new relations. By means of the lymphy exudation they become more or less incorporated with the surrounding tissues, and, by attaching themselves around the cut portion of the bone form, in time, a closed capsule. A head to the bone is sometimes, in a measure, formed; in other

cases the end of the bone becomes attached to the cavity by fibrinous bands.

As suppuration will be excessive and often long-continued, nourishment and stimuli will be required during the treatment. When abscesses form in the surrounding cellular tissue they should be opened. It is a matter of but little importance in what position the limb is placed, and how it is secured, provided its position is comfortable to the sufferer. The uneasiness and irritation which the splints and bandages give, do much to prevent success. In the upper extremity it matters little what length of limb the patient has, provided his life be saved and the convalescence be speedy. A shortened arm does not affect its usefulness, and a slightly changed direction can be corrected in the after-stages of the treatment. The most effectual management is the simplest, and tedious daily dressings are to be discouraged. Straightening the limb upon the bed, a pillow, or a long, broad splint, without complicated or elaborate bandaging, is the best and most comfortable dressing for any resection. The patient is kept in bed until the suppurative stage is established, when he will be permitted to get up. His arm is then placed in a sling, and the water dressings are continued until a complete cure is effected. When the parts are nearly cicatrized it will be time enough to apply the tumefaction bandage for removing the œdema of the limb. Anchylosis rarely follows this operation in the shoulder-joint.

Of the cases of resection of the shoulder performed in the Crimea but few died; and all those saved regained a useful limb, possessing all the motions, with the exception of those of the deltoid, which muscle is, to a certain extent, paralyzed from the division of its nerves, which can not altogether be avoided in ex-

posing the head of the bone. As a proof of the efficacy of resection, Stromyer excised nineteen shoulder-joints with a loss of seven, chiefly from pyæmia. Of eight cases in which the operation was required, but, from some mitigating circumstances, was not performed, five died.

Sixty-eight cases of resection of the shoulder-joint have been reported to the Surgeon-General's office, of which forty-eight were successfully treated, the patients regaining very useful arms, the forearm and hand possessing all of their former movements.

Comparative Table of Resections of the Shoulder-joint.

	Cases.	Deaths.	Per cent.
English in Crimea	16	3	19
French in Crimea	38	21	55
Confederate service	67	20	30

This operation was not performed as frequently as necessity required. Many cases of necrosed joints from gunshot wounds of the shoulder are daily applying to examining boards for extension of furlough, in which an anchylosed joint, with useless and impoverished limb, exists, and also fistulæ of many months, and even two and three years' duration, from which is kept up a thin, ichorous discharge, with the periodical escape of pieces of bone.

Gunshot wounds in the neighborhood of the elbow-joint are much more readily recognized, by the escape of the synovia, etc., than injuries of the shoulder. Inflammatory reaction runs high, as in all cases in which joints have been opened by a ball. Collections

soon form, and the excessive swelling stretches the softened capsule, which, giving way, allows of the burrowing of pus and final discharge through open abscesses. After running a tedious, painful, and dangerous course, if the patient escapes with a shattered constitution and an anchylosed limb, it is as much as he can expect. When the bones forming the elbow are not involved, the treatment consists in repose, keeping the joint immovable, with the free application of cold water, and the administration of opium to allay pain and quiet nervous excitement.

Should the wound be of such a character as would probably be followed by disastrous inflammation, then a primary resection offers a diminution of the risks to life, a rapid convalescence, and a movable joint. In the Schleswig-Holstein army, of fifty-four amputations of the arm, nineteen died; while of forty resections, under similar circumstances, only six died. In the Confederate service, of two hundred and fifty cases of amputation of the arm there were sixty-five deaths, while in forty-five resections of the elbow there were nine deaths. The results of the operations were also modified by the period at which the resection was performed. Of eleven cases excised within twenty-four hours before reaction ensued, but one died; of twenty cases between the second and fourth day, or during the stage of irritation or excitement, four died; and of nine cases operated upon between the eighth and thirty-seventh day, only one died—an exemplification of a general rule laid down in the commencement of this chapter, that the wounded bear operations before the stage of reaction, or after the establishment of suppuration, much better than they do while suffering under high inflammatory excitement. This shows the necessity of deferring secondary opera-

tions until the proper time has arrived which experience has determined.

It can not be expected that an arm, after a serious gunshot injury to the bones, will be cured without deformity. The arm will always be shortened, where many spiculæ have been removed. We acknowledge this fact in anticipation, and never attempt, by traction and counter-extension, to restore it to its former length. We simply place the arm in an easy position, and allow the muscles to approach the broken ends. This course is opposed to that adopted in the treatment of simple fractures, where the main object is to prevent deformity, and, especially, shortening of the limb. As this object is discarded in compound fractures of the upper extremity, the treatment is thereby much simplified, and the patient is saved much annoyance and suffering.

In simple fractures of the arm, the pasteboard splints are to be preferred; while, for the forearm, wooden splints, made of light material, and *wider* than the diameter of the arm, will make the best application. The tumefaction bandage is not required, and in gunshot fractures is altogether discarded. In gunshot injuries, where we have an open wound to dress daily, our mechanical applications should be of such a character as to permit of easy inspection. and also the ready readjustment of the apparatus when disarranged, while, at the same time, the splints are kept secure. The serious objection to bandaging compound fractures is in the abundant discharge saturating the dressing, and in summer rendering it necessary to renew it daily, if not twice a day. Every movement of the broken limb being very painful, but little bandaging should be used, so that the wound is open to inspection, and the limb can be daily dressed without

disturbing its position. Diachylon plaster is now extensively used to secure splints to fractured limbs three or four bands encircling the limb will always retain the supporting apparatus, while the limb, at its wounded portion, remains uncovered. When the pasteboard is moistened, it moulds itself to the arm and makes a very satisfactory dressing.

As soon as the patient has passed the reactive stage he should no longer be confined to his bed, but, with his arm in a sling, may obtain sufficient exercise to keep his system in good condition. The erect position will have the additional advantage of permitting the ready discharge of pus and prevent the bagging of this fluid, and will obviate the necessity for the establishment of counter-openings. In all simple fractures the excess of callus depends upon the degree of mobility between the broken ends. In compound fractures the deposit for consolidation is usually very great, which may be explained by the amount of irritation from inflammatory action, and also by the difficulty of keeping the fragments at rest. Fortunately this does not interfere with the final results, as false joints are not more frequently met with in compound than in simple fractures. Experience shows us that there is not that necessity, which many practice, of frequently tightening the apparatus, to the very great annoyance of the patient. If the constitution be strong, a considerable degree of relaxation may be permitted, and be found not incompatible with perfect consolidation. In animals with compound fractures we see continual exemplifications of this fact—their broken bones becoming united, notwithstanding the continued motions of the limb, in the absence of all retentive apparatus.

The local and general treatment of the wound will,

in no respect, be modified on account of the fracture. Water dressings, until cicatrization is completed, medicated with astringents to allay profuse discharges, or with antiseptics to remove fætor, or with stimuli to promote granulations, will be the proper course, while the general health is watched, retarded secretions promoted, and debility guarded against. If fragments of bone have remained and have become necrosed, the surgeon must assist nature in their expulsion, otherwise they will be surrounded by new formations, and, as sequestra, incarcerated in an involucrum, will only be expelled after much time and trouble. When spiculæ are suspected, the wound should be examined from time to time, and especially about the eighth or tenth day from the receipt of injury, when the swelling has subsided to such an extent that the finger can be introduced. During the excitement of reaction all examinations of the wound should be interdicted. As soon as we conclude that all fragments have been removed, we desist from further probing, as it can not but be injurious to the delicate granulations.

Cleanliness is necessary to successful hospital practice in the treatment of supparating wounds, but, when excessive, becomes a serious obstacle to rapid cicatrization. It is a common error for surgeons to place a wounded limb over a basin of water, and sponge and rub it as if they were cleansing a piece of porcelain. I have seen others cleanse gunshot wounds by the free use of a powerful syringe, with which they poured a stream of water into the wound until the granulations were bleached and the water returned discolored with blood, and this repeated with great regularity at the morning and evening visit. It was not surprising that wounds, treated with this over-care, took a very long time to heal.

This too liberal use of the syringe is a very common error with surgeons, who overlook the protective influence of healthy pus in their over-estimate of excessive cleanliness. I have seen a surgeon, in a case of resection of the shoulder-joint which promised a speedy and successful cure, put the beak of a syringe into one of two or three fistulous tracks by which the ligatures had escaped, and distend the cavity until jets d'eau spouted from the opposite orifices, the perpsiration streaming from the face of the patient, and the distorted countenance indicating the unnecessary torture which the surgeon was inflicting. Was it singular that the case retrograded from the time this rude and ignorant practice was instituted? and could any other result have been reasonably expected?

If the wound be gangrenous, and the object be to remove ichorous decomposing fluids, to diminish or prevent absorption and general poisoning, then the syringing is desirable; but under no other conditions should the granulating surface of a wound be washed. Wipe around the edges and remove any secretions which might have collected upon the skin, but leave the pus, as the best covering which healthy granulations can have. Under its protection the plasma, which is thrown out from the blood-vessels, will rapidly form tissues; but rub or wash away this covering, and the exposure to the baneful influences of the atmosphere will rapidly destroy the granulations which had already formed. However useful the local and general bath is to advance the cicatrization of a suppurating wound, do not generalize too much, and expect equally good service from cleansing the granulations.

Compound fractures, under the very best conditions, are tedious cases, and in gunshot injuries our patience will often be taxed to the utmost. Despondency should

not be an element in the character of a military surgeon. We must expect to have a compound fracture under treatment at least twice if not three times as long as would be required to consolidate a simple fracture.

Should the main vessel be injured, in connection with the fractured bones, we have not sufficient cause to sacrifice the limb; but, ligating the artery at its bleeding mouths, we treat the fracture as if this complication had not existed. Owing to the free anastomosis of the blood-vessels of the arm, mortification is not to be feared when a ligation is applied even to the brachial artery; a circuitous route soon supplies the needful nourishment to the parts beyond. Should the nerves as well as the artery be injured, or the principal nerves be divided with the bones, then the limb, even when saved, would be a useless, paralyzed extremity, and its immediate removal will save the patient a long, tedious, and dangerous convalescence. We pursue a similar course when the soft parts are extensively lacerated. In such cases it is our duty to sacrifice the limb to diminish the risks to life.

The elbow-joint, for gunshot wounds, transfixing its capsule and fracturing the bones, is best resected from the back of the joint, the patient lying upon his abdomen. There are no important vessels on this posterior portion of the arm, and only one nerve—the ulna—which must be sought on the inner side and avoided in the incision, or paralysis of all the muscles supplied by it will follow its section. When the posterior ligaments are divided and the joint exposed, only remove the fractured head and all foreign bodies, and do not interfere with that bone which has not been injured. The lips of the wound are closed by sutures, and cold water dressings become the principal treatment. The

limb is placed upon a pillow, and not disturbed, if possible, until suppuration is established. When the soft parts are cicatrizing, and healing is nearly completed, passive motions in the joint will prevent anchylosis, and a tumefaction bandage will remove the œdema of the limb.

Instances of successful resections are recorded for injuries at the wrist-joint, where the spiculated ends of both radius and ulna have been satisfactorily removed; also, instances in which either of these bones have been removed entire, for chronic ostitis and necrosis brought on from gunshot injuries. Similar incisions to those recommended for the resection of the elbow-joint will expose the heads of the wrist bones, and permit of the ready removal of any injured portion. In this, as in all other cases, we must save all tendons passing over a joint to supply distant bones; and in the wrist, particularly, many of the muscles which supply the fingers can be drawn out of the way, and thus escape section.

When a ball perforates a wrist-joint, although inflammation will run high, with much persistent swelling, pouting orifices, and profuse discharge, such cases, with patience and cold water dressings, will eventually do well. This is an instance of gunshot wound of a joint, with fracture of the bones, which rarely requires amputation. In such injuries the hand and forearm is carried upon a straight splint until the inflammation and swelling subside, when great care must be taken to avoid the contraction of the fingers and hand by using daily passive motions, and by rubbing with such stimulating embrocations as will promote the absorption of deposits in and around the sheaths of the tendons.

However frightful an injury involves the hand, it is

very seldom that it is so mangled as to be beyond the pale of surgical skill, and unless it is literally ground up it should not be amputated. In certain cases fingers may have been already torn off, or may be hanging by a fragment of skin, when they should be removed; but for ordinary gunshot lacerations of the hand, amputation of the entire hand is very rarely required.

Different bones of the hand and wrist are to be removed when irrevocably injured, with or without the metacarpal bones of the fingers or the thumb. Any fingers which can be saved will be better than the best artificial limb. In cases of lacerated hands, in military surgery, when attempts are made to save the limb under cold water dressings, the inflammation which comes on makes a shocking limb to those unaccustomed to treat lacerations of this extremity; but at the end of eight or ten days, when suppuration has been well established and granulations are forming, the swelling subsides, the torn portions are drawn together, cicatrization advances rapidly, and often but little deformity remains; at least, the patient retains a useful limb. Some surgeons lay down the rule that an amputation of the hand is never imperative, however frightful the injury to it may appear; and there is much truth in the assertion.

In the inferior extremity we find the treatment of gunshot injuries somewhat different from those of the upper limb, on account of the minor degree of vascularity, and the much greater tendency to mortification, so that the rule to which we called attention, of amputations being rarely required for the superior extremity, is reversed for the leg, where it is often the only way of escape left to save the life of the wounded.

We have elsewhere stated that when balls embedded

themselves in the pelvic bones, and their position could be discovered, provided a serious operation is not needed, they should be removed, as their presence will, sooner or later, give rise to trouble. All loose spiculæ should also be taken away, and, as sequestra frequently show themselves from time to time during the treatment, they should be withdrawn.

When the ball strikes lower down, in the neighborhood of the trochanters, it usually splinters the bone, and frequently involves the ilio-femoral articulation. Such injuries are of the most serious character, and are usually considered fatal. It is a question of much moment to inquire how can modern surgery, with all of its appliances, improvements, and experience, assist in saving the life and limb of such seriously wounded? Within a few years the rule for all compound fractures of the femur was amputation of the limb; but the statistics from military hospitals in time of war are so frightful—but few successes for the numbers treated—that it was naturally suggested that the risks could not be materially increased by letting the patient take the chances with his limb on; when, if his life were saved, it would be with and not without his leg. This has settled down into a conviction for fractures of the upper third of the femur, which are now treated without amputation, inasmuch as nearly every amputation in the neighborhood of the trochanter, and, with very rare exceptions, all at the hip-joint, are fatal.

If we are assured that the ball has crushed the head of the bone, then the operation of resection offers the best prospects of success for the patient; but it does not always follow that this diagnosis can be clearly made out, if the signs of intra-capsular fracture be not present. Military surgical experience shows that a

fracture of the upper portion of the shaft of a bone does not necessarily extend into the head, and *vice versa*. Unless the junction of the epiphysis with the shaft is struck, the fracture is more likely to be confined to a centre of ossification—so that in the thigh, as in the arm, a blow just below the trochanter will not usually fracture the head of the femur. When the joint is opened and the head of the bone fractured, the wound should be enlarged, or an opening made into the joint from the outer side of the hip, by which the fractured head might be removed.

If any success is hoped for, those cases alone should be selected in which neither blood-vessels or nerves are injured, nor the soft parts extensively torn. If all or any of such are involved, where experience teaches us that the chances for successful resection are more than doubtful, do not have recourse to amputation, which is so certainly fatal, but let the patient live his few remaining hours or days without being haunted by the ghost of a useless operation. Should he revive the reactionary stage, and still retain a good pulse and comparatively unshattered constitution, then a secondary operation might give a chance of success. In the Crimean service no amputation in the vicinity of the hip-joint was successful—every individual case died. In the Confederate service but one successful case of primary amputation at the hip-joint is reported. This only corroborates the experience of other campaigns, and also shows the inutility of such mutilations. When death from a crushed thigh-joint is inevitable, it is hardly humane to amputate under the plea of giving to the patient the benefit of the chances which experience teaches us are nugatory.

As regards resections in suitable cases, the report is a little more satisfactory. Of six resections performed

by the English surgeons in the Crimea one was successful, and the condition of all operated upon was made more comfortable. Had the conveniences for treatment been greater, and the general sanitary condition of the troops better, with less pyæmia, hospital gangrene, cholera, and scurvy, much better results might have been obtained. Some of the cases were doing well, with every prospect of final success, when they were swept off by one of the above diseases. In amputations at the hip-joint all the cases died speedily.

In cases of resection, the greatest difficulty lies in the after-treatment. As it is not expected to restore a perfect limb, no good result can be obtained by using violent extension. The leg, however, must be fixed, to facilitate those movements in the changing of position, which are necessary to the patient's comfort. A long, straight splint is used for this purpose by some surgeons, while the inclined plane, or Smith's anterior splint, which I would much prefer, is depended upon by others. Some have bandaged the limb to the sound one, and speak of it as a good mode of support. Water dressings compose the local treatment.

Baudens succeeded in saving both limb and life in cases in which compound fractures of the upper half of the thigh were treated without operation. Consolidated and useful limbs, with but little deformity, are reported as having been saved. By the use of the fracture-box and inclined plane he succeeded in curing a compound fracture on a level with the trochanter—saving a useful limb, although he had extracted two inches of the shaft of the femur. His experience proves that compound comminuted fractures of the upper half of the thigh are not so fatal when attempts are made to save the limb as when the thigh is amputated. The experience of surgeons, derived from the

wounded of the Confederate campaigns, would establish a similar course of treatment, as excellent limbs were saved where fractures had occurred in the upper third of the femur, while amputations in the immediate neighborhood of the trochanters met with the usual fatality.

As the resection of the hip is so much more successful when performed for disease than for injury, it has been suggested, by surgeons of experience, that an exception to the rule of immediate resections be made for the hip-joint, and that such cases, even the most suitable for the operation, be deferred until suppuration is well established. For hip-joint resections it is said that nothing is lost by this delay, while, on the contrary, there may be a chance of saving the limb without an operation. Larrey, in 1812, reported six cases of gunshot fractures of the neck of the femur, with three cures—showing that the prospects are not altogether hopeless. When the patient is, in a measure, placed in a similar condition to those affected with diseases of the bones, his prospect for a successful resection appears to be improved. Baudens says that, as the resection of the hip-joint only succeeds as a secondary operation, attempts should first be made to save the limb.

We preface the following table, taken from Armand's *Histoire Medico-Chirurgicale de la Guerre de Crimée*,* with the suggestion that any surgeon who has ever had a successful case of resection at the hip-joint has always been eager to publish it, while many have been disposed to hide their misfortunes from the public—so that the tables, showing the relative advantages of primary and secondary resections, appear in their very best light.

* Paris, 1858, p. 102. [illegible]

Primary Resections after Gunshot Wounds.

SURGEONS.	Operated upon.	Cures.	Deaths.
Larrey. (Volume 3, Clinique)	6	..	6
B. Cooper. (Dictionary)	2	..	2
Leteille. (Relatione du Siege d'Anvers par M. H. Larrey)	1	..	1
Hutin. (Memoires de Medicine et de Chirurgie Militaires	2	..	2
Sedillot. (Annales de la Chirurgie Francaise et Étrangère	5	..	5
Guyon. (Expédition de Churchill, Algére)	1	..	1
Rychet. (Journées de Juin, 1848	1	..	1
Aubiot. (Thèse de Montpellier, 1840)	3	..	3
French Crimean Service	9	..	9
McLeod. (Crimean War)	5	1*	4
Stromyer	1	..	1
	36	1	35

* This successful case was found, after the articulation had been laid open, not to be a fracture extending within the joint, but confined without the capsule; and we are, therefore, justified in the belief that the case would have done equally well without the resection.

Secondary Resections after Gunshot Wounds.

SURGEONS.	Operated upon.	Cures.	Deaths.
Larrey. (Clinique, volume 5)	1	1	..
Guthrie. (Clinic, volume 5)	1	1	..
Baudens. (Traité des Plaies d'Armes a feu)	1	1	..
Ferussac. (Bulletin des Science Medicales, volume 3)	1	..	1
Robert. (Journées de Juin, 1848)	1	..	1
Guersant. (Journées de Juin, 1848)	1	..	1
Vidal. (Traite de Chirurgie)	1	..	1
Mounier. (Constantinople, 1854	3	..	3
Legouest. (Constantinople, 1854)	1	..	1
McLeod. (Crimean War)	1	..	1
	12	3	3

The reports of hip-joint resections at the Surgeon-General's office are exceedingly meagre. I know of several unsuccessful cases of primary resection, and two cases of successful operation, in one of which the

patient could walk well by using a cane. The number of cases is not known, however, with sufficient certainty to offer any percentage of cures.

It has been suggested that, if the patient who has been operated upon could have facilities for slinging the whole body, it would afford many advantages in the management of excisions of the hip-joint.

A compound fracture in the upper third of the thigh should be treated, in every respect, as if in the arm. Unless the leg is so mangled that an amputation is an act of necessity, it should not be thought of. We have already said that, in field military surgery, amputation of the thigh in the immediate vicinity of the trunk is nearly synonymous with death, while many gunshot fractures in this region are saved. The following tables will throw much light on this subject.

Consolidated Table of Compound Fracture of the Thigh, treated without amputation, made up from records in Surgeon-General's office, from June 1, 1862, to February 1, 1864—prepared by Surgeon H. Baer, P. A. C. S.

	Recoveries.	Deaths.	Days.	Inches.	Remarks.
	116	105	...	....	Besides the foregoing, there are forty-seven undecided cases.
Average period of recovery...	...	...	104	....	
Greatest period of recovery...	...	...	255	....	
Least period of recovery......	...	...	41	....	
Average period of death......	...	...	52	....	
Greatest period of death......	...	...	185	....	
Least period of death........	...	...	1	....	
Average amount of shortening.	...	...	...	1.9	
Greatest amount of shortening.	...	...	...	5	
Least amount of shortening...	...	...	...	.5	

Consolidated Table of Amputations of the Thigh, collated from records in the Surgeon-General's office, from June 1, 1862, to February 1, 1864—prepared by Surgeon H. Baer, P. A. C. S.

	Upper third.		Middle third.		Lower third.		
	Cures.	Deaths.	Cures.	Deaths.	Cures.	Deaths.	Total.
CIRCULAR.							
Primary	19	11	33	14	42	27	146
Secondary	3	7	7	14	12	21	64
FLAP.							
Primary	6	4	15	10	35	11	81
Secondary	3	1	3	9	5	5	26
METHOD NOT STATED.							
Primary	15	22	24	21	35	27	144
Secondary	4	16	5	19	14	35	93
Total	50	61	87	87	143	126	554

Besides the foregoing, there are ninety-seven cases of amputation of the thigh recorded, but the result not being ascertained, they were excluded from this table. The mortality appears graver on this, and all other tables of capital operations, than truth would warrant, inasmuch as many of these deaths occur within the first few days after a battle, before the patient has passed out of the hands of his regimental surgeon, or while still at the field infirmary. Those who do not die there are sent off to hospitals, and some taken off to private quarters by their friends, and never again heard of—while *all who die*, as above stated, are recorded. This will, perhaps, not only account for the large percentage of deaths, but also, in a measure, for the want of a better correspondence with tables made under more favorable auspices.

The treatment must commence on the battle-field by proper transportation; the judicious removal of fractured limbs is as important as an operation, and any neglect in this department will deprive the wounded man of all hope of retaining his limb, or of having his life saved We will carefully remove all spiculæ, dilating the wound, if necessary, by a bold incision, to facilitate the thorough removal of all for-

eign bodies. Until suppuration is well established, the limb is kept in an easy position and surrounded with cold applications. All tight, retentive bandages are to be rejected, as they interfere with topical antiphlogistic applications. Dispense with bandages. Should the case not have been carefully examined soon after its occurrence, and every fragment of bone removed, whether detached or not, a careful examination for foreign bodies will be necessary on the eighth or tenth day, when the reactionary stage has passed, when all portions of bone found in the wound should be removed. If not, as sequestra, they will become incorporated in the new osseous formations, and be the cause of much trouble and suffering.

In all compound fractures, with much loss of bone, it is always injurious to attempt to obtain a limb of equal length with the sound one. It can not be done, and the chafing and annoyance of splints and tight bandaging may react very seriously, if not fatally, upon the constitution. The first thing to be attended to is to prepare facilities for treating such a fracture. If we are striving for successful results, we must not expect to obtain them if a patient, with a compound fracture of the thigh, is being treated upon the ground, or is lying upon a little straw. He must have a proper bed and a good firm mattress, prepared with a bed-pan hole for facilitating nature's daily wants without the necessity of moving him.

Upon this the patient is placed, lying on his back, with the leg extended. Two long straps of diachylon plaster are attached to the sides of his leg from the knee to the ankle (see figure 3, plate 24); they form a loop under the foot, and a weight is swung from this over the foot of the bed. This will be sufficient to tire the muscles and make the necessary degree of exten-

sion; or the limb might be loosely attached to a long thigh-splint. The tumefaction roller is inadmissible, and strips of adhesive plaster or strips of bandage will secure the limb to the splint, and at the same time leave the wound open for inspection and dressing. For the first week or ten days this will be all the apparatus needed. As the case advances and inflammation subsides, with a diminution of purulent discharge from the wound, splints may be more methodically applied by using long inner and outer splints of light board, well padded with loose cotton, and secured in position by bands of adhesive plaster or with tapes. The extending bands are made by adhesive strips, attached to the sides of the leg and carried under the foot, where they are secured to the end of the splint. Allow the ends of the bones to fill up the void made by the extraction of the spiculæ, as this hastens consolidation.

A better method of treating fractures of the thigh is in the use of Smith's anterior splint, or Mayor's posterior wire splint (see plate 25), by which the limb is suspended. Smith's anterior splint is formed of a strong iron wire (three-sixteenths of an inch) bent in the form of a parallelogram, as long as the limb, and five inches wide. Cross-pieces of the iron prevent the sides from collapsing, and are also used for suspending the limb. This wire splint is placed upon the anterior surface of the limb. While traction is being made upon the foot by an assistant, which removes all shortening, the splint is secured by enveloping the entire limb in a roll of bandage, omitting the bandage at the points where the ball has perforated. When this bandage is nicely adjusted it should be covered with a thick solution of starch, which will glue all of the bands together, and form a mould for the limb, which sup-

ports it equally throughout its entire extent, and gives great relief. *When properly applied, the patient should be altogether free from pain.* The limb is then suspended two or three inches above the bed, by passing cords from the upper and lower cross-wires of the splint, all of which, uniting in a single cord, is attached to the ceiling or top of the bedstead. With the limb thus suspended, the patient may move about in the bed at pleasure, without fear of disturbing the adjustment or giving himself pain. As the roll of bandage has been omitted at the site of the wound, local applications can be daily made and the parts duly inspected. This has become the favorite method of treating compound fracture of the lower extremity in the Confederate service; although the anterior splint is better adapted to compound fractures of the leg, where it offers every desirable facility for successful treatment. The very great advantage which it possesses is in allowing the patient to shift his position without moving the bones at the seat of fracture, and this assists in preventing bed-sores. It also uses the body for counter-extension, and in this way overcomes muscular contraction and excessive shortening. The greatest objection to its use is that, as the splint requires nice adjustment, careless manipulators find in it a very troublesome appliance, with constantly shifting bandages, badly supporting the limb, and inducing the bagging of pus. When carefully applied, it always gives satisfaction.

Mayor's posterior splint, although a much older apparatus, is still used with great advantage in compound fractures of the lower extremity. The principle of action is the same, viz: suspending the limb so as to ensure rest of the broken ends; while, at the same time, the patient is permitted to shift his position, and

avoid bed-sores from continued pressure. In Mayor's posterior splint the injured limb receives a firm, regular support from the unyielding splint. Smith's splint, on the contrary, supports the limb only by the bandage, which, in successive turns, passes around the leg and the splint. The comfort of the apparatus will depend altogether upon the care and regularity with which this bandage is applied. If some bands are drawn tighter than others, instead of presenting a smooth plane, moulded upon the limb for its perfect and painless support, the irregular adjustment will suspend the sensitive extremity by a few cords or tight bands, which, by their irregular support, can not but produce much suffering. In the hands of a nice manipulator, Smith's anterior splint is the perfection of a fracture apparatus; for general use, Mayor's posterior splint is decidedly preferable. Another decided advantage which Mayor's splint possesses is, that as the limb is only secured at a few points, nearly the entire extremity is exposed for inspection or the application of remedies. (See plate 25.)

With the exception of the mechanical appliances for the broken bone, the case is treated as for a long-continued suppurating wound, by avoiding, in all cases, depletion, and by giving liberal diet. Many of these cases will die; but if we have facilities in a well-ventilated and well-organized hospital, we will have the satisfaction of saving nearly half of the patients submitted to our care. Of 221 cases of compound fracture of the femur reported by Confederate surgeons as treated in military hospitals from June 1, 1862, to February 1, 1864, 116 were successful; while of 554 thighs amputated, 280 recovered.

In fractures of the middle and lower third of the thigh, not implicating the knee-joint, the question

will again recur, what course is to be pursued with such? These are still very serious cases, and are classed with those of the upper third. Where attempts are made to save them, as recommended by Guthrie, the fatality will not be very dissimilar to fractures nearer the trunk, and the successes will depend upon the state of health of the sufferer and the conveniences for treatment.

There are cases which often appear so trivial—only a small bullet-hole leading to the crushed bone—that it seems barbarous surgery to condemn the limb without an attempt at saving it. The young military surgeon expects much from conservative surgery in such cases. We are informed by the experienced that this striving after conservatism is the main cause of the heavy mortality.

Surgeons from civil life are not prepared to believe how dangerous compound fractures of the thigh are in military surgery, until the unwelcome truth is forced upon them by an ever-recurring experience that many lives are sacrificed to attempts at saving these broken limbs. In civil surgery, or with every facility in military hospitals, we should attempt to save the limb—it is the proper course to pursue—but on the battle-field, with the deteriorated material upon which we are operating, and the poisoned atmosphere of the wards into which the patient is to be carried, and the rough transportation to which he must be submitted, it is often a fatal error. Military surgeons are often forced to abandon their conservative intentions to expediency. It is for such cases that primary amputation offers the best chances for life. In rejecting amputations we lose more lives than we save limbs. As a rule, amputations are less hazardous the greater distance we operate from the trunk; and the reason why

amputations are usually urged for compound fractures of the lower and not upper portions of the femur is, that the chances being similar without it, amputations are much less fatal in the lower than in the upper half of the thigh.

With the light of recent experience, and the advantages found in removing all fragments which, as thorns in the flesh, are the direct cause of much of the suffering, suppuration, and fatal accompanying symptoms, the urgency for amputation is not so great as in former wars, and many lives and limbs can now be saved by adopting this rule of practice.

Surgeons in the Crimea often had cause to regret attempts at saving fractured thighs, but never regretted an early amputation. The improvements in more recent practice warrant us in adopting a more conservative surgery.

Resection, or the cutting off of the sharp spiculated ends from the shaft of the femur, for a compound fracture of the bone, has been frequently recommended, and often practised; but the experience of latter years discourages its performance, as the operation is as serious as the condition for which the remedy is used. When the splinters of bone are removed, there is considerable space for the play of the rough remaining edges, which, therefore, give but little trouble.

Should we attempt to save a fractured thigh in its lower third, which we should do in many instances, where the soft parts are not extensively torn, or important vessels and nerves injured, the first and essential step to success consists in a careful exploration of the wound, and the removal of *all fragments of the bone crushed by the ball, whether these fragments be loose or not.* Even should the shaft for three or four inches be found broken up, remove all of it. It is these

fragments which cause the irritation and profuse suppuration which, in most instances, destroy life in gunshot fractures. They all have their nutrient vessels so injured that they rarely consolidate; they nearly always die; and it is in attempts to throw off these that nature exhausts herself.

Should the orifice not be sufficiently large to permit the thorough cleansing of the wound, enlarge the opening. It would be well should this operation be performed at the first dressing. If unavoidably deferred until the reactionary stage has passed, it would be of decided advantage to perform it at any time after the first week. The earlier it is accomplished the sooner irritation is allayed, and the more rapidly a cure is effected. The after-treatment consists in keeping the leg extended upon the bed, and the wound under the influence of cold water dressing. As shortening must occur from the loss of bone, putting the leg immediately in retentive apparatus, so as to keep it to its former length, will be a cause of irritation which would be injurious, and the free discharge of pus would so soil the dressing as to necessitate its reapplication daily, which would be very trying to the patient.

For the first fortnight, successful results are best promoted by keeping the limb in an easy position, with a wet cloth over and around the wound, which can be frequently renewed without disturbing the leg. When the period of excitement has passed, the limb may be then kept quiet or stiffened, by using either a straight splint with the starch bandage, leaving an opening corresponding with the wound, or the leg can be comfortably secured upon an inclined plane, as seen in plate 24, figure 5, which represents a very convenient form of apparatus. The treatment in all

of these cases will be very tedious—the average of cure, as collected from reports to the Surgeon-General, being 104 days; the longest period being 255, and the most speedy cure 41 days. This, however, we may lay down as a rule: that recovery is expedited for every fragment of bone that we remove, the most satisfactory results being connected with their early and thorough removal.

The following case, from the Soldiers' Relief Hospital, Charleston, under Surgeon W. H. Huger, will exhibit the advantages of the course which has been so strongly recommended above. Private R. A. Howell, Company H, 21st South Carolina regiment, was wounded by a minie ball at an assault upon Fort Wagner, 10th of July, 1863. He was taken prisoner by the Federalists, and after two weeks exchanged, when he entered the hospital. The ball had traversed the limb antero-posteriorly, at a junction of the middle and upper third, crushing the femur for a distance of from four to five inches. When received, the suppuration was excessive and exhausting. Large pouches containing pus bagged in his thigh, and hectic fever, with its accompanying emaciation, had already made marked inroads upon him. When motion was imparted to the thigh, the broken fragments could be moved about so freely as to impart the sensation of foreign bodies in a bag. The finger passed into the wound detected also denuded and movable fragments. Upon consultation, it was determined to lay open the limb and remove all fragments, as the only course offering any prospects of saving life, as his daily increasing debility admonished us that he could not hold out much longer in his present condition; and the wound was so near the trunk, and large abscesses had so dissected the soft

parts, as to render an amputation near the trochanters extremely hazardous. Under chloroform the operation was very protracted. After removing all the loose and dead portions of bone, it was found that large masses firmly connected to the soft parts by a thickened periosteum, and still firmly adherent by an intermediary deposit of new bone, were perfectly denuded upon their free surface, and when removed showed clearly the process of death in such fragments, and their incarceration by new osseous formations. All such fragments, however firmly connected with the soft parts, were taken away, comprising very nearly five inches of the shaft of the femur. The patient rallied from the operation, and an improvement in his case commenced from that moment. Under liberal and stimulating diet the suppuration gradually diminished, and he became cheerful, with good appetite. He was furloughed on November 3—the wound having completely healed, and perfect osseous union effected, with, however, a slight angular deformity at the site of union—it having been found impossible to avoid the displacement of the upper fragment, as no devised splints seemed to meet the requirements of the case. Had this case not been operated upon, there was every prospect of a speedy death; and in similar fractures, where life had been spared, necrosis, suppuration, and suffering remain permanent companions of the wounded.

In compound fractures of the lower portion of the thigh, the inclined plane is found the most convenient apparatus, as it offers the most comfortable position to the patient, but has the disadvantage of promoting the burrowing of pus, which, in working its way down the limb, may dissect passages for itself as far as the buttock, and, by its multiplied openings, unless cor-

rected by a firmly-applied roll of bandage, causes much annoyance, as well as destruction to bones and muscles.

Mayor's patent wire splint, which combines the advantages of the inclined plane, will be found a very comfortable mode of dressing.

The anterior wire splint of Smith is found also useful in these fractures, although a straight, long splint, so attached as to keep the broken ends of the bone quiet, and so stiffen the limb that it can be lifted without pain, forms a most serviceable apparatus. Whatever be the appliance, the wounds must be allowed free vent for their discharges.

When the knee-joint is implicated in a shot wound, or cut open by a shell, with injury to the head of the tibia or femur, experience has shown that, however trivial the wound may appear, if the synovial sac be entered, and air be admitted, or a foreign body lie within the joint, violent synovitis, with great pain, swelling, and heat, and with excessive inflammatory fever, will come on after twenty-four or thirty-six hours. Should the patient survive the inflammatory stage, erysipelas, pyæmia, or hectic will ultimately destroy life; and although, on the other hand, the effusions may be absorbed, and an anchylosed but useful limb saved, it is a very rare occurrence. If the soft parts are not much lacerated, or the blood-vessels and nerves behind the joint injured, such cases are well adapted for resection, and excellent results are obtained in practice.

A straight or elliptical incision over the anterior portion of the joint, across its entire diameter, will expose the interior and enable the surgeon to remove the foreign bodies, whatever they may be, and with them the head of the injured bones. The section of

the bones should be made in such a way that the surfaces will adapt themselves to each other—usually the patella is removed. When the external wound is closed by sutures, union by the first intention may, to a certain extent, be obtained. In the successful cases the bones eventually become firmly united, and, with an anchylosed joint, the patient retains a useful limb.

After the resection, a long splint upon the back of the leg, reaching from the buttock to the heel, is all the apparatus required, while cold water dressings alone are applied around the joint. In cases of resection the surgeon must not expect quick union in the wound, as that does not often occur in military surgery. A tedious suppuration, the formation of numerous abscesses, and often the exfoliation of portions of bone, is the rule, requiring care and judicious management to obtain a final success—many of those operated upon being lost by the action of those deleterious causes which affect injuriously all wounds in military hospitals.

When attempts are made to save the limb in what we suppose to be a trivial or doubtful case of knee-joint injury, we should follow the routine of the antiphlogistic treatment. In a single puncture of the capsule, even when synovia has escaped, the orifice may heal by quick union. When local inflammation ensues, and runs such an acute course that the free application of leeches—twenty to forty to a limb—the continued use of cold water or ice dressing, with the general treatment of opium and small doses of antimony, etc., does not quell the inflammation, and we are led to infer that pus has formed within the joint, the articulation *should be largely opened, and the joint thoroughly cleansed*, whether we resect the heads of the bones or not. There is no longer injury from the admission of air,

while there is serious fear of destruction of the cartilages should the collection of pus be retained. This free opening of the articulation may, in some cases, obviate the necessity for secondary resections and amputation, as excellent results have been obtained by this apparently bold surgery—-the patient saving his life and limb. The effect of this incision into the joint, in allaying the general irritation, is marked.

As a rule, gunshot wounds of the knee-joint are so fatal that the experience of military surgeons confirm the necessity for amputating all such cases. In the reports from many military hospitals every case of perforating wound of the knee, in which no operation was performed, proved fatal; and of all the cases reported from the army to the Surgeon-General's office, we find but 50 successful cases out of 103 cases treated.

The course which will be pursued with a fracture of the bones of the leg must depend upon the extent of injury to the soft parts, and also the facilities at hand for treating fractures. Our main object is always to save life, and, if possible, the limb also; but in our too-grasping disposition we must be very guarded how we jeopard the one to save the other. It is in this respect that military surgery is so very different from civil practice. We are continually compelled to sacrifice limbs to expediency, when, under more favorable conditions, we would not hesitate to practice conservative surgery. To introduce a single example: where a long and tedious transportation becomes necessary after a battle, it would be expedient to amputate much more freely than we would do were there hospitals in the immediate neighborhood of the battle-field where the wounded could be treated. How, for instance, could we transport, with any chance of success, a resected joint, such as the shoulder, or a gunshot-

fractured thigh or leg? Under such circumstances an amputation would give the patient a much better chance for life, which should always be the main object.

When facilities offer for attempting the preservation of a fractured leg, the same precautions are taken as in other fractures, for removing immediately all loose or very movable fragments of bone. The limb is placed in a fracture-box, or upon the double inclined plane, and by the constant application of cold water, while we use those remedies already suggested for keeping down an excessive reaction, we watch the progress of the case, and meet the various complications as they arise, by the rules of practice which have been already frequently discussed.

It is in this class of fractures that Smith's anterior splint, or Mayor's posterior splint, will exhibit a long list of splendid triumphs—cures without deformity, and with the smallest amount of shortening; a painless treatment, allowing the patient to move about at will, and even leave his bed the first week after the reception of injury. Should mortification appear in the wound a few days after the injury, we will find in early amputation the only means of safety.

Resections of the ankle-joint have not been followed by that success which has characterized operations upon the larger joints, especially the knee and the elbow. It is recommended as a conservative measure, but is seldom practised. When gunshot injuries occur about the ankle, crushing the bones, excision offers but a meagre resource. Mortification often follows such injuries, and amputation holds out stronger inducements for immediate and subsequent benefit.

Gunshot wounds of the foot, with extensive crushing of the tarsal and metatarsal bones, frequently

require amputation in these joints. In ordinary perforations of the foot by balls, even with injury to the bone, a cure is eventually effected; but such cases are always tedious, months elapsing before the patient can support his body upon the foot, and much pain attends pressure. The treatment differs in no respect from that laid down in general rules. Removal of osseous fragments and cold water dressings comprise the treatment. When the foot is so mangled that an amputation is considered best for the patient, the foot can be removed at any of its articulations.

We have often referred to the fact that amputations will ever be a necessity in military surgery; and, according to McLeod, had they been more freely practised in the Crimea, a large number of lives would have been saved.

Among a certain class of surgeons, on the contrary, however, amputations have often been performed when limbs could have been saved, and the amputating knife has been often brandished, by inexperienced surgeons, over simple flesh wounds. In the beginning of the war the desire for operating was so great among the large number of medical officers recently from the schools, and who were for the first time in a position to indulge this extravagant propensity, that the limbs of soldiers were in as much danger from the ardor of young surgeons as from the missiles of the enemy.

It was for that reason that, in the distribution of labor in the field infirmaries, it was recommended that the surgeon who had the greatest experience, and upon whose judgment most reliance could be placed, should officiate as examiner, and his decision be carried out by those who may possess a greater facility or desire for the operative manual.

As a general rule, the following conditions necessi-

tate the loss of a limb, viz: When an entire limb is carried off by a cannon-ball, leaving a ragged stump, or when a limb is literally crushed up, although still attached to the body, it will be necessary to amputate to form a good stump; also, if the principal vessels and nerves are extensively torn, even without injury to the bone; or if the soft parts are much lacerated; or in cases of extensive destruction of the skin—as such cases offer very tedious cures, if cicatrization is ever obtained. Again, in severe compound fractures, and often in apparently simple compound fractures, where experience teaches us that, although the wound may appear trifling to-day, in attempting to save it we will sacrifice life a few days hence. Amputation is compulsory when mortification of the limb rapidly follows upon an injury; also when, in compound fractures or perforated joints, the profuse discharge or the continued irritation threatens a fatal issue; again, where joints are crushed, and where resections are not admissible; or where a fracture of the shaft of a bone extends into a joint; also in cases where secondary hemorrhage can not be controlled by the ligature, or by any other hemastatic. Knowing that in such cases, sooner or later, the life will be jeoparded, we must anticipate these troubles by amputation.

Military surgeons have long made the important division of amputations into primary and secondary—a division of great practical importance, and which forces itself upon our notice by the relative mortality following the two operations. Amputations for direct injury, which are performed after the shock has passed off, but before inflammatory symptoms make their appearance, are styled primary; those required for cases of mortification, profuse suppuration, secondary hemorrhage, or for necrosis, are called secondary or

mediate, and comprise all amputations performed after the first twenty-four or forty-eight hours, when reaction has set in. A third division of intermediary amputation is a subdivision of the secondary, and refers to cases amputated from the second to sixth day.

An examination of the following table will show, satisfactorily, the advantages of operating early.

CONSOLIDATED REPORT OF AMPUTATIONS, FROM RECORDS IN SURGEON-GENERAL'S OFFICE, FROM OCTOBER 1, 1862, TO OCTOBER 1, 1863.

	THIGH.				LEG.				ARM.			
	Cures.	Deaths.	Results not stated.	Total.	Cures.	Deaths.	Results not stated.	Total.	Cures.	Deaths.	Results not stated.	Total.
Primary........	72	84	126	282	96	48	109	253	118	23	188	329
Intermediary...	14	24	20	58	13	11	18	42	22	11	9	42
Secondary......	16	65	22	103	18	33	25	76	45	31	28	104

	FOREARM.				AMPUTATION.			
	Cures.	Deaths.	Results not stated.	Total.	Cures.	Deaths.	Results not stated.	Total.
Primary........	25	4	30	59	311	159	463	933
Intermediary...	4	1	5	10	53	74	52	152
Secondary......	11	4	14	29	90	133	89	312

The very large number of results not stated is accounted for by those amputated upon the field, some of whom fall into the enemy's hands; others are sent to private hospitals, or are treated in private families by physicians who are not in the army, and who, therefore, make no report of the case. While in many cases only the number of operations are reported, but as the cases are still under treatment the final results can not be given. If we be permitted to divide the list of unknown results proportionately between the cures and deaths, which would give us even a larger proportion of deaths than occur, as the cases scattered through the country usually recover, it will exhibit the most successful army practice of modern times.

I here insert a comparative table of amputations from recent wars, showing the result of practice among those whom we are accustomed to consider the best surgeons, and to whom we are indebted for most of our medical and surgical knowledge. When it is remembered that the French and English include all cases of minor amputations, viz: of fingers and toes, in their report, while the Confederate report for one of the three years of the war comprises capital amputations only, our great success will be appreciated.

COMPARATIVE REPORT OF ARMY AMPUTATIONS.

	Cases.	Deaths.	Per cent.	Remarks.
English in Crimea..	998	273	27*	Includes all minor amputations of fingers, toes, etc.
French in Crimea..	4,466	3,131	70	
Confederate army..	1,688	631	37	

* Capital amputations alone performed in Confederate army from June 1, 1862, to February 1, 1864.

The relative success will be more conspicuously brought out by comparing the results in any one amputation, viz: that of the thigh, which is considered by far the most fatal in military surgery.

COMPARATIVE STATISTICS OF AMPUTATION OF THIGH.

	Cases.	Cures.	Deaths.	Per cent. of mortality.
Crimean war	1,664	123	1,541	.92
Confederate war, June 1, 1862, to Feb. 1, 1864	507	256	251	.49

In amputations of superior half of thigh the Crimean mortality was ninety-four in every one hundred operated on, while our reports for the year 1863 give a mortality of fifty-seven in every one hundred, or the recovery of nearly half of our cases.

The experience of every battle-field shows that the mortality following the amputation of limbs which require immediate operation is always less than those performed some days after the infliction of the wound —although the milder cases were those retained, and the most severe those selected for immediate operation. As all military surgeons recognize the propriety of amputating condemned limbs within twenty-four or thirty-six hours after the injury, before inflammatory reaction has set in, the subject requires no discussion. The rule in military surgery is absolute, viz: *That the amputating knife should immediately follow the condemnation of the limb.* These are operations for the battle-field, and should be performed at the field infirmary. When this golden opportunity, before reaction, is lost, it can never be compensated for.

The rule in performing primary amputations is to

operate as far as possible from the trunk, as every inch diminishes the risk to life. This rule is so general, that when an amputation can be performed at a joint, never amputate higher up. The only exception made to this rule is in the knee-joint disarticulation, which, on account of its large synovial surface and inflammation which follows, gives very bad results. In examining our statistics for disarticulations, it will be found that of eleven cases of amputation through the knee-joint nine died; while of sixty-seven amputations in the lower third of thigh, forty-three died.

In secondary amputations it may not be expedient to follow this rule; necessity, or the desire to save life, which is always paramount, may compel us to amputate at a distance from the injury, as in cases of mortification. If the rules for primary amputation be followed, viz: of removing, at once, all limbs in which the blood-vessels and nerves are extensively injured in connection with the crushing of the bones, there would be seldom gangrene to require a secondary amputation.

When mortification attacks a limb, it will be known by change of color in the skin. When it occurs in the leg, which is its common seat, the foot changes from the natural flesh color to a tallowy or mottled white; the tissues in a measure liquefy, are cold, and become offensive—breaking up into more or less extended sloughs, saturated with an ichorous fluid. This gangrenous condition may stop at the ankle, either above or below it, depending upon the seat of injury; or it may creep up to the knee, where it equally shows a disposition to limit its extension. When the ankle limits the mortification, we amputate below the knee; when otherwise, above it. These cases are usually unsatisfactory, as a general poisoning is soon effected, and the stump, wherever made, is attacked in a few

days, sometimes in a few hours, as if by a continuation of the same gangrene.

In mortification of the stump, upon the upper portion of a limb, a second amputation is inadmissible. By the local use of pure nitric acid to the mortified surface, or the concentrated Labarraque's chloride of soda, or pyroligneous acid, we strive to limit the extent of the slough; while, with carbonate of ammonia, quinine, brandy, and strong food, we support the system until some improvement makes its appearance in the stump. When all the sloughs have been eliminated, and the stump has commenced to cicatrize, let time remodel the old amputation.

Having condemned a limb, we should wait until the nervous shock—from which most of the wounded suffer—subsides, and then give chloroform. Should we not have the time for its proper inhalation, we may inject a half grain or more of morphine under the skin, which will produce a rapid blunting of nervous sensibility; and in five minutes, or even in less time, the patient will be in a fit condition to stand the operation with the least degree of constitutional shock.

In the performance of all serious operations, when possible, there should be three assistants. One aid gives the chloroform; a second compresses the main artery, which is much better than using the tourniquet —an instrument which is now, in a great measure, discarded from practice—and a third holds the limb and supports the flap during the section. The aid who administered the chloroform during the incisions, can assist in ligating the arteries. Military surgeons prefer the circular operation to the flap, which they only use in the exceptional cases. With the circular stump, covered only by skin, there is less soft tissue to suppurate and slough, and a much more rapid cicatriza-

tion is effected. Experience, which has long recognized the utility of the circular operation for the leg, has now generalized it as the most useful amputation for the thigh or arm.

As the soft parts, muscles, etc., are divided perpendicularly to the bone in the circular method, there would be fewer blood-vessels severed, and those would be cut across at right angles; while in flap amputations a large artery coursing through the flap, after passing the point where the circular incision would have divided it. might give off several branches, all of which would be cut, and then so obliquely that they would require much more care in ligation. Small vessels, when cut obliquely, do not contract to occlusion as readily as when divided perpendicularly to their axis. Moreover, as the vessels are much more numerous, secondary hemorrhage is more likely to occur in flap than in circular amputations. Another objection urged against flap operations is that the nerves run through the entire flap, and their divided ends are exposed at the extremity which forms the cicatrix. The pressure upon these ends by the indurated cicatricial tissue, is a frequent cause of painful stumps. In circular amputations, the flap being formed of skin alone, and the nerves being divided on a level with the bone, there is no fear of like incarceration.

The rapidity of making flaps, which is often offered as an inducement for adopting this method, should not influence the surgeon in his choice—as, under chloroform, a few seconds, or even minutes, more or less, is of no moment either to operator or patient, nor does it affect in any possible way the final result. When we hear of surgeons boasting that they can take off a leg in so many seconds, we always attach to them a desire to gain the applause of spectators at the expense of

the patient's safety. I have seen operators belonging to this class who would make a frightful gash in perinæum and bladder, so as to ensure the extraction of a calculus in the shortest possible time, to the wonder and astonishment of a large assemblage of professional men, while a few days of fatal suffering would disclose the price at which the false reputation has been purchased. The spectators, however, who lose sight of the case, know nothing of this natural consequence. Safety to the patient is of the first moment, rapidity in performing an operation being altogether of secondary consideration. The reputation of a surgeon should be measured by his successful cases, and not by the number of seconds he takes to slay his patients.

Having assigned the aids to their posts, and seen that all the necessary instruments which may be needed are at hand—for a surgeon should never commence an operation until he has satisfied himself on this score—the surgeon removes the limb, ligates the vessels, and, when all oozing has ceased, secures the stump by points of suture placed at intervals of an inch, or a little less, along the entire line of wound.

In dividing the skin, the surgeon can not be too careful to leave an ample flap to cover the heads of the bones. This is the first and most important rule in amputation. You can not well leave too much skin, and can very easily commit the opposite error. The surplus of skin will be absorbed; a deficiency can in no way be supplied. The rule is, to have the flaps so ample that no tension be necessary in closing the wound. One of the most constant, as well as one of the most frightful, exhibitions in those military hospitals where the surgeons have not yet gained experience, is the protrusion of the bones from the stumps of amputated legs, necessitating a second operation should the patient sur-

vive the first. A little care will obviate this trouble, and save the surgeon much mortification. Any omission in this respect must be corrected before the stump is dressed; and if the bone is found so long that the skin can not be made to cover it without traction, remove a section of bone with the saw, and not attempt, through want of honesty, to conceal a badly-performed operation, and make the innocent patient the victim of our misplaced pride. *In ligating the vessels, tie every artery which bleeds, or is likely to bleed.* It is not derogatory for a surgeon to apply ten, fifteen, or even twenty ligatures to a stump; it shows that he understands his profession; experience has taught him the great trouble and annoyance of reopening a stump to find a bleeding vessel, when he has but little time to attend to the urgent demands of the wounded. *The rule is, neglect no small artery.*

As adhesive straps for supporting and sustaining the flaps are antagonistic to water dressings, they are useless in amputations, and are not used. Only a small strap is necessary to secure the ligatures upon the limb at one angle of the wound, and prevent these threads from being unintentionally pulled off from the vessels, before the processes necessary for obliterating permanently the arteries have been completed. Sutures are recommended in all operations, and, in amputations, should be sufficiently numerous to keep the flaps in perfect apposition. As they are not removed for four or five days, they obviate much after-dressing. A single layer of wet cloth is applied to the stump; this, in turn, is covered by a piece of waxed cloth or oiled silk to keep in the moisture, and either an ice bladder or water by irrigation is continuously applied over this outer cloth. The case should now be looked upon as a wound, and should be treated accordingly. The course

laid down for wounds is here strictly applicable, and should be closely followed.

In certain cases of amputation, as in the circular, where the skin alone forms the flap, the dressing may be changed, as follows: After applying sutures to the entire length of the wound, draw the intervening spaces accurately together by means of strips of isinglass-plaster, and cover, also, the length of the wound with a folded strip of the same, only leaving uncovered the most dependent angle where the ligatures escape, and where drainage from within is permitted. The object of the dressing is to convert the wound into a subcutaneous one, excluding the air and hastening union. To the stump no other dressing is applied than a wet cloth, frequently renewed or kept moist by irrigation. At the expiration of a week, the removal of the straps will show complete cicatrization along the line of incision. In healthy patients, and in a pure atmosphere, a rapid healing of stumps may in this way be obtained. The isinglass-plaster will alone answer for this dressing—the diachylon being too irritating, and not sufficiently pliant to seal, hermetically, the wound. We find but little use for ointments in dressing recent stumps—the wet cloth being much simpler, not irritating, and, therefore, more efficient.

During the treatment of all wounds in military hospitals, previous want and exposure, which belongs to every army, however well organized, will show their influence; and if, from misguided views of the pathology of inflammation, the plan of abstemious or antiphlogistic diet be adopted for those operated upon, the mortality will be heavy. Liberal feeding shows its good effects in the after-treatment of amputations; and the great difference in the surgical statistics of the French and English depends more, perhaps, upon

the diet in their hospital practice than upon any one other cause. Tisanes can not support a person in ordinary health, and certainly can not support him under the additional drain of an exhausting suppuration. If patients are placed under identically similar conditions, the successful treatment of amputations will be found to lean to the side of those who are the most liberally supported. Slops are out of place in a surgical hospital, and good cooking will be found as useful as good nursing. Let nature be our guide. For the first one or two days after a serious operation, there is but little disposition to eat. Under such conditions, I would not advise food to be forced; but, as soon as the patient expresses a desire to eat, foster his appetite with good, strong, nourishing, easily-digested food, and let his supply be liberal. Any attempt at starvation will be highly injurious.

If the patient escapes the ordinary diseases incident to hospitals, viz: erysipelas, gangrene, pyæmia, etc.,—we must be extremely careful of him about the tenth or twelfth day. When the ligatures are escaping from the arteries, absolute rest should be insisted upon, and the patient should not be allowed to exert himself in any way until this fear of secondary hemorrhage is passed. We have elsewhere stated how this complication is to be met.

Among the accidents to which recent stumps are exposed, we find hemorrhages, spasmodic twitchings, excessive sensitiveness, often amounting to severe pain, and protrusion of bone, with necrosis. When, upon examination, a few hours after a stump has been dressed, it is found hard, enlarged, and glistening, with the sutures drawn, and apparently burying themselves in the skin, the patient complaining of the pain of tension, the cause will be found in internal

hemorrhage. Under the sedative action of loss of blood, or the depressing effects of pain, etc., the heart's action had been so lowered that a condition approaching syncope had been brought about, accompanied by a tardy and feeble circulation. Such vessels which bled freely when first divided, under this loss of *vis a tergo* force, ceased to bleed. The stump looked dry, and was closed by suture. As soon as the patient gets warm under reaction, blood is driven with more force through these open-mouthed vessels, the small clot which temporarily plugged them is dislodged, and the cavity of the stump, made complete by the close apposition of the flaps, is gradually filled with blood. If there be no outward escape for the blood, it clots, and thus stopping the orifice of the vessel, permits the more permanent clots to form within the divided calibre—so that often, when the sutures are cut, the stump freely opened, and the clotted blood emptied out, no bleeding vessel can be found. Should the bleeding point be discovered, a ligature, which should have been used during the operation, must now be applied. It is the frequent occurrence of such accidents, necessitating a reopening of stumps, that teaches an experienced surgeon to neglect no bleeding vessel. If there are too many small oozing points, and the surgeon is desirous of leaving as few ligatures in the wound as possible, I have found that forcibly breaking a thread around these small vessels will, by cutting through their inner contractile coats, crush their walls to the obliteration of their calibre, and thus put a stop to the bleeding, without the necessity of leaving the thread in the wound. When such hemorrhages occur after a stump has been dressed, it is necessary to remove the clot from the cavity of the stump, so as to obtain, if possible, direct union between the flaps.

Under certain conditions there is a general oozing from the entire surface of the stump, which is very difficult to control, and which depends upon a hemorrhagic diathesis induced by the depressing influences of camp life. Legouest, in his Crimean experience, mentions many instances of this capillary oozing. Direct pressure upon the bleeding surface, the elevation of the stump, cold applications, the local application of the persulphate of iron, and indirect pressure upon the main vessel, will suffice to stop this drain. As this condition will likely induce an unhealthy action in the stump, and probably sloughing, with secondary hemorrhage, the general system of the patient must be improved by liberal diet. Secondary hemorrhage, which comes on from the eighth to the fifteenth day, about the period of separation of the thread from the main vessel, will be met by ligating the artery in the stump, if possible, or above it, according to the rules laid down so fully in page 207.

We sometimes observe, after amputation, that an irregular action is excited in the divided muscles, with a tendency to contraction or twitching, which causes the stump to be disturbed, moving it from its position, or even lifting it from the bed upon which it is lying. As every movement of the sensitive extremity is very painful, this spasmodic muscular action in the stump becomes an annoying complication, which demands control from medicines. A bandage applied around the limb is often used to allay these twitchings, and is supposed to be beneficial by the pressure and support which it affords to the divided muscles. Most frequently, however, some one of the nervous sedatives, of which opium is the chief, is necessary to quiet this irregular, painful action. This spasmodic action of the muscles accompanies recent amputation, and is

rarely seen when the operation has been performed over ten or fifteen days.

When cicatrization has commenced, a second accident may appear, consisting in a severe pain locating itself in the end of the stump, and often radiating up the limb. The pain is one of pressure or tension, and is at times very severe. It is accounted for by an incarceration of the ends of the divided nerves in the cicatricial tissue, which, in hardening, exercises painful pressure upon them. This condition is not so likely to occur in circular as in flap amputations, as the cicatricial line in one case is formed of skin alone, while in flap operations the nerves extend to the very extremity of the flap, and are often incorporated in the cicatrix. Under certain circumstances a morbid action is set up in the extremity of the divided nerve, with exudation among the nerve filaments, resulting in the formation of a tumor which incorporates and compresses painfully the extremity of the nerve trunk. Whenever persistent pain exists in a healed stump which anodynes can not remove, some such pathological condition must be suspected, and the compressed nerve be liberated, or its diseased extremity excised.

The most important accident to which a stump is liable is from exposed bone, called usually a conical stump, the pathology of which is not generally understood. This condition has been very frequently attributed to carelessness in operating, and by many is always traced to a deficiency of flap. Experienced surgeons, however, meet with this condition of protruding bone where every care had been taken during the amputation to leave even a superabundance of soft parts, and where the end of the bone was amply covered. Again, its presence has been attributed to an irritability of the muscular envelopes of a stump which,

by their excessive retraction, expose the end of the bone. There is no doubt that the muscles do retract, but instead of the cause, it is rather as the effect of a previously existing disease. The true cause of conical stumps is found in an inflammation of the lining envelopes of the bone, both periostial and medullary, but more especially the latter. Either from some peculiar condition of the patient or atmosphere, or from the direct injury which these nutrient membranes of the bone receive from the saw, an inflammation is excited. The medullary membrane takes on the general suppurative inflammation with all the tissues of the stump. It becomes red, swollen, and thickened, soon filling up the entire medullary canal, and even protruding, fungus-like, from the smoothly cut end of the bone. In connection with this inflammation, the nutrition of the bone becomes impaired, the periosteum as well as the medullary membrane separates from the exposed end, which leaves a white, denuded, osseous rim. The soft parts of the stump will not unite over this fungoid mass from the medullary cavity, but, gradually receding on all sides, leaves it eventually the most prominent portion of the surface. From exposure the bone is darkened, and the medullary granulations desiccate into a hard, black, greasy crust, intimately attached to the end of the bone. In the progress of the case, under long-continued suppuration, with the formation of sinuses and fistulous openings, the envelopes of the bone still further separate from the extremity of the shaft, so that a probe can pass up, for some distance, alongside of the bone.

In the meantime nature has set up her eliminative action, and by slow steps is isolating the denuded, necrosed portion. After many weeks some motion can be imparted to the blackened protruding prominence

of bone, and soon after it is found so detached that it can be pulled off, coming away as an irregular cylinder, smoothly cut where the saw had traversed it, but very spiculated in the direction of the shaft. These prolongations are sometimes four and five inches long, showing to what a distance the disease had extended in the medullary cavity.

As the pathology of conical stumps can be clearly traced to a destructive inflammation of the medullary and periostial membranes, the plan of treatment can be as clearly laid down. No benefit can be derived from a course recommended of making traction upon the soft parts by means of bandages and plasters, so as to draw the muscles of the stump over its extremity. The result would be the incarceration of a necrosed bone. Nor is the risk of a second amputation justifiable, as no surgeon can foretell the extent of the inflammation, and to what height the disease has involved the shaft. In cutting off an inch of the bone we may leave two or three inches of sequestra behind. The only judicious course to pursue in the accident of conical stumps, is to await patiently the elimination of the dead bone, knowing that, in time, the entire extent of diseased bone will become detached, and can be readily removed, when the stump will heal rapidly. The history of this war has given us interesting cases in which medullary necrosis, following upon amputations in the middle of the thigh, had exfoliated the shaft of the bone as high up as the trochanter. As the rule of treatment for conical stumps with necrosed bone is to await patiently the separation, any instrumental interference is meddlesome surgery, and always injurious.

Whenever operations are to be performed in military surgery, *chloroform* should be administered. It is a remedy which the surgeon should never be without,

and which might be used on all occasions with advantage, whether for operations or for dressing painful wounds, as in the cleansing of compound fractures. The effects of chloroform are wonderful in mitigating the suffering of the wounded, and it is often instrumental in the cure of wounds, from the rest and tranquillity of mind which follows its inhalation. It also prevents excessive reaction in the paroxyms of traumatic fever. During the performance of capital operations on the battle-field, death sometimes ensues from nervous exhaustion, produced by excess of suffering; the use of chloroform relieves the patient at least from this risk.

The universal use of chloroform to allay the pain of surgical operations, is a complete vindication of the utility of the remedy, and proof of its necessity. For ourselves, we place unlimited confidence in its judicious administration, and use it without hesitation under any circumstances. We hope that the humanizing tendencies of the age, in introducing this invaluable comfort, has banished that dread of being cut as an item to be considered when operations are necessary; and we hope to see anæsthetics used as liberally in allaying the pain of surgical affections as cold water is now used for keeping down inflammation. *We do not hesitate to say, that it should be given to every patient requiring a serious or painful operation.* We may hear, now and then, of an accident from its administration; but who can tell us of the immense number who would have sunk from operations, had it not been administered?

In its administration we must use the following precautions: The best apparatus is a folded cloth, in the form of a cone, in the apex of which a small piece of sponge is placed. This is at first held at some distance from the nose and mouth of the patient, so that the

first inhalation may be well diluted with air. As the exhilarating stage is reached, the cloth should be approached to the nose, so that a more concentrated ether may be inhaled, which will rapidly produce the desired insensibility. Noisy breathing is the sign that the anæsthetic effect is produced, when the inhalation should be suspended, and the operation commenced. Unless the operation is very tedious, do not renew the inhalation.

Ingenious inhalors are more or less complicated, and are, on that account, more or less inefficient. The great perfection of the above-mentioned apparatus is its simplicity. Finding that much chloroform is wasted by evaporation from the handkerchief, I have for some years used a common funnel as my inhalor, which protects the hands of the person administering the chloroform, and prevents the loss from general evaporation. If a piece of heavy wire, or a small bar of tin, be attached across the interior of the funnel, about half-way toward its throat, the sponge containing the chloroform can be supported between this bar and the side of the funnel, leaving a space on one side for the air to rush over the surface of the sponge as it comes through the elongated end of the apparatus, when the air, loaded with ether, is inhaled. The funnel should be large enough to cover the lower half of the face, including the nose and mouth, and the sponge should not come within two inches of the face—for, should it touch the skin, it would blister it. The eyes, being excluded from the apparatus, are not annoyed by the evaporation of chloroform. As the funnel does not fit accurately to the lower outline of the face, there will be ample spaces on either side of the chin to admit air for diluting the vapor.

Besides a great saving of chloroform, which is no

small recommendation, the use of this instrument obviates the fear of suffocation, which is always present to my mind when I see chloroform carelessly administered. When the cloth is used, should the patient struggle—a very common occurrence—or should the assistant administering the anæsthetic be at all interested in the operation, the cloth is thrust down upon the face of the patient, respiration is impeded, and suffocation is imminent. Suppose the patient has already been influenced to such an extent that he has lost the voluntary control of his muscles, and can not pull away the cloth, he is in a very dangerous condition, and the continued thoughtlessness of the assistant might suffocate him. I can readily understand, in this way, why deaths should sometimes occur from the carelessness of administration, and am only surprised that it occurs so seldom. Were we as careless in the use of other potent remedies as we are of chloroform, cases of poisoning would be largely increased. In times of hurry, confusion, and excitement, as after a battle, we can not surround the safety and well-being of the wounded with too many guards for their protection.

Of the many thousand instances of its administration since the war between the Confederate States and United States began, but two fatal cases from chloroform inhalation have been reported. In one, the patient died in a few minutes after inhalation was commenced. In the other, the patient did not die for several hours. The case was that of a healthy young soldier, who had a minie ball embedded under the scapula, and who, while *en route* to rejoin his command, stopped at a hospital, and desired its removal. The operation was very tedious, and he was kept under the influence of chloroform for one and a half hours. Al-

though he regained his consciousness when the administration was stopped, his pulse never reacted, notwithstanding the liberal use of brandy. A few hours after the operation was completed there appeared an increasing disposition to sleep, which gradually ended in coma, the pulse becoming more and more feeble. He died thirty-two hours after the inhalation. As the operation affected no vital part, and as the health of the patient was good, his death could be attributed to no other cause than the inhalation of chloroform.

STIFF JOINTS AND DEFORMED LIMBS.—I have had my attention frequently called to the number of anchylosed limbs, resulting from gunshot fractures of the shaft of a bone, or even from simple flesh wounds. These deformities are caused, in most instances, by the misapplication of splints and bandages. Nothing is more common, in army experience, than to see a sling worn for months for a gunshot wound of the arm or forearm. The injury, usually a compound fracture, or perhaps only a flesh wound, after some days' treatment in a hospital, may have been found so rapidly improving that, with the prospects of an early cure, the patient was given thirty days' furlough, and sent home. From neglect, or injudicious treatment, the process of the cure was retarded; and, after an extension of furlough of thirty days, he reports to a hospital or examining board with wound healed, but with a stiff joint. Wounds of the forearm frequently leave, as sequelæ, when they are not properly watched, contracted fingers and stiffened wrists. Anchylosis of the elbow is also a frequent accompaniment of such injuries, as well as of injuries of the arm.

During the treatment of every gunshot wound of the upper extremity, when it is necessary to carry the

forearm and hand upon a board, or the arm in a sling, it is the common custom to wear the apparatus until the wound is perfectly healed. When this is accomplished, the patient throws aside the sling; but finding that the limb, after being carried for a long time in an elevated position, is congested immediately when it is allowed to hang, he becomes alarmed at its swollen, discolored, and painful, or rather benumbed, condition. After a few minutes' trial he elevates the limb, and as he finds in it immediate relief from these disagreeable sensations, he reapplies the apparatus, with the intention of wearing it until his arm becomes strong enough to bear the depression. In this opinion he is often sustained by his physician, who tells him that, eventually, all will get right. After frequent attempts at allowing the limb to hang, with the same results as at first, he gives up all hope of ever getting the use of his arm, and carries it day and night in a sling. Unless he is exceedingly fond of the excitement of an active campaign, he rather cajoles himself with the frequent renewal of his furlough. Eventually he finds that he has lost all power of movement in the elbow-joint, which has become anchylosed. In gunshot wounds of the thigh and leg a similar stiffening of the knee-joint often results from the position in which the leg is for a long time carried—semiflexed, to relieve the painful tension of the muscles.

When a limb has been supported for even a few days, the veins appear to lose their tonicity, and are easily distended by the weight of a column of blood; so that, when the arm or leg is hung downward, the blood stagnating in the veins distends all of these vessels, congesting the limb, and producing a painful exaggeration of numbness. Should there be an ulcer upon the extremity, venous blood will at once trickle from its sur-

face—having burst through the attenuated walls of the vessels, as the column of blood exercises more pressure than these feeble vessels can bear. This loss of tone is readily restored after a few days' use of the limb.

In cases where the arm has required support for some time, as in compound fractures, when a cure has been perfected, and the necessity for using a sling has passed, the following course has been found beneficial: After dropping the arm for even a few minutes, as soon as it becomes painfully congested it should be raised, and supported by thrusting the thumb or hand in the buttoned coat or vest. When the arm has rested sufficiently, allow it again to hang down; and, by frequently repeating this manœuvre, in a few days tone will be restored to the vessels, and the painful distension from position corrected. If the medical attendant does not urge the patient to this course, and explain to him the pathological condition, so that he can intelligently assist himself, the tonicity of the vessels will be daily deteriorating, instead of the arm gaining strength. Frictions over the limb with a stimulating embrocation will assist materially the member, and even dry rubbing is found very strengthening to the vessels by stimulating the nerves, which, in turn, control and restore action in the blood-vessels. The splints, and especially the sling, should be discarded, as soon as they have fulfilled their usefulness. Cases of neglect of this important rule are so numerous, when wounded men are allowed to be treated at home on furlough, that the propriety is very questionable of allowing them to leave the hospital, until a cure is so far progressed as to enable them to dispense with all apparatus.

When stiff joints are presented for correction, it is important to know whether the anchylosis is false or

true; whether produced from a permanent contraction of the muscles around a joint, or from fibrinous and osseous formations within the articulation and between the heads of the bones, ultimately joining these, or even blending them. When a wound has occurred at some distance from a joint, which has become stiff during a tedious course of treatment, the presumption is that the anchylosis is spurious, or resulting from contracted muscles and shortened ligaments, the effect of a long-continued and restrained position. If, when an attempt is made to straighten such a limb, strong, hard tendons, as cords or stays, are felt prominently under the skin, preventing extension, the most speedy and certain relief is found in the subcutaneous section of such cords. Chloroform is administered, and the limb extended forcibly until the contracted tendons become prominent. A delicate tenotomy knife is then passed under them, and, by turning the sharp edge of the blade outward, exercising, at the same time, a sawing motion, the tendons will suddenly yield, and the limb can then be readily extended. It would be bad policy, however, to straighten the limb at once, inasmuch as the divided extremities of the tendons would be so separated from each other that a very indifferent bond of union would be formed between them. The better course is to replace the limb immediately in its contracted position, and support it in the same by a splint and bandage. At the end of a week the ends of the divided tendon will have been glued together by an abundance of plastic material, which will be found so yielding in its character that, if a splint, with a movable joint, as seen in figure 1, plate 24, be now attached to the limb, and by means of the screw be gradually straightened out a little every day, at the end of three or four weeks the tendons will have become so much elon-

gated by the yielding of this plastic deposit as to permit the ready straightening of the limb, and the removal of all contracting deformity.

Plate 24, figure 1, shows the kind of angular splint best adapted to false anchylosis of the elbow, which is a very common accident after a compound fracture of the arm or forearm. Figure 4, plate 24, gives the design of a similar apparatus for straightening the knee-joint. Where no tendons become prominent or require division, the angular splint alone will suffice for removing the contraction. The biceps tendon at the elbow-joint, and the hamstring muscles at the knee, are the tendons requiring division. After section the limb should not be immediately, but gradually, straightened. With ordinary care, and a little anatomical knowledge, the operation of tenotomy becomes a simple and usually very successful expedient. Permanently flexed fingers and toes, when caused by injury to the muscles of the arm or leg, are very easily straightened by division of the contracted tendon.

When inflammation has occurred within, or in the immediate vicinity of, an articulation, the cause of stiffening is found in a deposit of lymph, which ties the heads of the bones more or less intimately together, restricting all movements in the joint. Such cases require a different treatment. These muscles may not be immediately at fault, and, therefore, would not require division. The proper mode of proceeding is, under chloroform, to flex forcibly the limb, breaking up bands of adhesion. They can be felt to give way under the hand, at times, with an audible noise. *In the elbow, as well as in the knee, the limb is straightened by first flexing it.* Bend the forearm until it lies upon the arm, and the knee until the heel touches the buttock. By this forcible flexion the main vessels of the extremity, all

of which pass over the flexed portion of the limb, are relaxed and not stretched, and, therefore, injury to them is avoided.

After complete flexion is effected, attempts may then be made to straighten the limb, without, however, using an excessive amount of force. An angular splint is applied, so as to retain the degree of extension and prevent recontraction. Inflammation and pain in and about the joint will likely arise, which will be controlled by the use of water dressings, either cold or warm, as most acceptable to the patient. At the end of a week or ten days, when the redness and swelling has disappeared, the splint should be removed, and the limb flexed and extended, in order to destroy any adhesions which may have reformed. This manœuvre is repeated daily, and continued until the limb is straightened—the angular splint being reapplied after it, and straightened a little more than on the preceding day. The splint must be worn day and night; otherwise the contraction of the muscles, by giving the most comfortable position to the limb, will restore the deformity.

When osseous union has taken place between the extremities of the bones, forming a joint, much more force is required to flex the limb; and often the fusion between the bones is so complete that it is found impossible, by a warrantable degree of force, to restore motion to the joint. Too much violence is not justifiable. If, by a moderate application of force, the bony union can be broken up, motion can be eventually restored to the joint. Inflammation will ensue, requiring local applications as well as general treatment for its control. When this subsides, passive motions of the joint should be daily made.

When, upon careful examination, in anchylosis of the knee-joint, the patella is found intimately attached to

the anterior face of the femur, no benefit can accrue from restoring motion between the extremities of the femur and tibia, as the attachment of the patella prevents all use of the quadruceps-extensor muscle, which is the anterior support and motive power of the leg. Such cases should not, therefore, be interfered with.

FROST-BITE.

Among the affections of the extremities which surgeons in the field are called upon to treat, during the inclemency of the winter's campaign, are those occasioned by exposure to cold and moisture. During the winter months an army usually suffers from these accidents in proportion to the privations which they are compelled to undergo—for well-fed and well-clothed troops do not readily yield to the injurious influences of exposure.

During the Crimean war, the two winters which the allied army spent before Sebastopol were very different in character. The winter of 1854–55 was not very cold, but was a season of continued rain; the soldiers were literally living in the mud, with wet clothes, which, for weeks, they had no means of drying; at the same time, the difficulty of procuring supplies was so great that their means of subsistence kept them just above starvation. Sleeping in wet boots as long as the boots were whole enough to remain on, and the continued maceration of the feet in snow and ice-water, caused a gradual diminution of the circulation and vitality of the toes and feet.

Very short allowance, unusual exposure, and very indifferent shelter, more than counterbalanced the absence of a very low temperature; and the result was that extremities, which could barely be kept alive, would be given over to disease under a temperature which would, under other conditions, be innocuous. The feet and toes would become swollen and œdematous, with a feeling of tension which gave much uneasiness during the day, with such an increase of pain toward night as, in many instances, to prevent sleep; the parts would be discolored of a brownish-red hue. In more serious cases, blisters would form upon the discolored surfaces, beneath which blood would extravasate. The drying and blackening of this would simulate mortification so closely as to be mistaken by the careless observer; the peeling off of this blackened pellicle would, however, expose either a new skin or an ulcerated surface. In feeble constitutions the parts attacked by this low inflammation break down into sloughing ulcers, characterized, in their future march, by chronicity, and an inactivity in the formation of healthy granulations; also an excessive secretion of a highly offensive, ichorous pus, with pale, greyish, exuberant, irritable, very painful, and bleeding granulations.

Like burns, the effects of cold show various degrees of gravity—from the redness and puffiness of a toe, through blistering of the surface and the formation of superficial ulcers, to the complete mortification of extremities and putrescent liquefaction of the soft parts—with the usual systemic irritation, general depression, and intestinal complications.

A second variety of frost-bite was well exemplified in the Crimea during the winter of 1855–56. At this period the soldiers were better clothed and fed, all

the comforts of army life were at their disposal, and the hygiene of the camp was in every respect good.

The temperature of this winter was so extreme that warm clothing could not retain the degree of heat necessary to support life in the extremities. Those who were much exposed first lost all sensation in their feet, so that no feeling would be imparted to the foot upon touching the ground, and then found some difficulty in walking, or even in supporting the erect posture. The feet, upon examination, would be found cold, livid, mottled, slightly swollen, hard, œdematous, and without sensation. The continued influence of cold would destroy the limb, causing it to shrivel and become dark. In time a line of demarcation would form, and the slow process of separation commence, leaving a chronic, fungus, sensitive ulcer, from which a fetid pus would be continuously discharged for months. As the fibrous tissues resist mortification they retain dead, blackened bones, which protrude from the face of the ulcer—a source of much annoyance, keeping up irritation, causing abscesses in the vicinity, and extending the mischief to contiguous bones. Should any attempt be made to remove these protruding and hanging phalanges, constitutional irritation, with increased pain, and a fungus condition of the ulcer, if not gangrene, were sure to follow.

The treatment which is found most useful in cases of frost-bite would be of a stimulating character, avoiding studiously the application of heat in any form.

Cold water and ice play an important part in the treatment of the local injuries induced by intense cold. Where the parts are swollen, painful, and discolored, frictions, with snow or ice water, is the popular mode

of treatment in arctic climates, where experience during the winter months verify its advantages. The frictions stimulate the tissues in which vitality has been depressed, while the continued application of cold prevents an excited action from overwhelming the weakened tissues and crushing out the little life remaining. These cold applications must be perseveringly continued for several days. Even when insufficient in themselves, they seem to increase the remedial power of other remedies. Similar results are obtained by local applications of spirits of camphor, turpentine, or sugar of lead and laudanum, or by painting the parts with tincture of iodine or a solution of nitrate of silver, or diluted nitric acid. Tannic acid, dissolved in glycerine, is highly extolled in chilblains, even when accompanied with ulceration. Under such applications the local symptoms will gradually disappear. For the more serious grades, with ulceration, stimulating and narcotic applications will be found the most useful, although a tedious cicatrization will accompany the most judicious treatment.

When mortification threatens, never use warm poultices, which I have seen applied in such cases—a certain means of ensuring an extensive destruction—but by frictions with cold, stimulating substances, try to excite new action in the parts; and, should the general system have been much depressed, stimuli and nourishing food, with the tonic preparations of iron, should be administered. Until the line of separation between the dead and living parts is well established, and the neighboring tissues have lost their discoloration, swelling, and induration, no amputation should be performed, as gangrene is likely to follow the irritation produced by the knife in such diseased tissues. As, however, these slowly decomposing masses would poison

the atmosphere of a hospital by putrefactive emanations, the course which was found most successful was to cut away the dead masses, and remove the sloughs, but without touching the living tissues.

In the majority of cases those surgeons who cut off the bones at the face of the stump, leaving nature to complete the cure, had the most satisfactory results. Experience, however, shows the process of cicatrization to be so slow, and the cicatrix remains so long sensitive, that a preferable mode is to amputate in healthy tissues, at some little distance above the well-defined line of separation. When the patient is in good health, or his system has been prepared by good food and stimuli, and when no gastro-intestinal complications are engrafted upon the local injury, this secondary amputation hastens the cure.

It may be necessary to modify the form of amputation in such cases. Where the toes have all been destroyed, the line of mortification is usually found as extensive in the sole as upon the back of the foot, which prevents the usual flap from being taken from the plantar surface. In such cases it is better to perform the circular amputation, making perpendicular incisions on the sides of the foot to facilitate the section of the bones; and as the bones of the inner side of the foot are much more extensive than those of the outer side, the line of circular incision should be oblique, to allow of a greater extent of soft parts on the inner side of the foot. It is not necessary to follow the contour of the joints in making these amputations. The much simpler plan is to use the saw rather than to disarticulate—which is at all times a tedious and troublesome operation, especially when, with the mortification of the anterior portion of the foot, the lever is destroyed, which assists so materially in exposing

the articular interspaces for the passage of the knife. General treatment must not be overlooked in frost-bite. It is a depressed system which predisposes to the affection, and which, by its injurious influence, retards the cure. The internal use of iron, barks, good food, etc., will be necessary in most cases.

MALINGERING.

In closing this Manual, experience induces me to offer to army surgeons a few suggestions regarding the frauds daily practised upon medical officers by impostors, who feign disease to escape military duty. *Malingering*, or the feigning of disease, has ever been, and will continue to be, popular with soldiers, irrespective of the material of which an army is composed. Honesty of purpose and patriotic motives are not the only incentives to enlistment, even against such an invasion as our enemies are now carrying on for the destruction of all our most sacred and cherished rights.

The odium heaped upon those who would remain at home, has forced many into the ranks who were but little disposed to give up their comforts and their habitual idleness for the active and laborious duties of camp life. Such soldiers are always ready to use every subterfuge for escaping from what is irksome and distasteful to them; and as complaints of indisposition offer an easy release, it is the plan usually adopted. Moreover, where large bounties are offered for enlistment, many are found who would enlist, obtain the bounty, and a suit of clothes, and, by feigning disease, successfully impose upon their medical officers, be dis-

charged from service, to re-enlist in a few days. Instances are known in which this course has been successfully pursued several times in a short period. Hence it is that the study of feigned diseases becomes an important branch of military surgery, both for the protection of the service and the detection of fraud. Unless medical officers are aware of impostors, and are always on the alert to detect and punish such impositions, the service suffers seriously, and the willing soldier is over-taxed with double duty.

Among the varieties of sickness classified as malingering, are slight indispositions much exaggerated; or the symptoms of disease may be purely fictitious, while diseased conditions, such as ophthalmias, ulcers, wounds, etc., may be either intentionally produced or aggravated by the malingerer.

General experience shows that, at times, one may be more or less depressed, with uneasy, nervous feelings, foreboding sickness. These are transient conditions, depending, perhaps, upon a disturbed digestion, and will disappear spontaneously at the end of a few hours, leaving us in our accustomed health. Ignorant or infatuated is that physician who believes medicine necessary for every such temporary indisposition, and who adopts the rule of prescribing drugs for every person who presents himself for treatment. This constant drugging is detrimental to the service, in making cases, and diminishing the effective strength of a command, while it squanders medicines which are only replaced with trouble and expense. A little moral courage on the part of the medical officer to refuse the applicant as a patient, and a word to the commanding officer to overlook his call for guard duty, will gain him the confidence and the respect of the soldier. The surgeon should not act hastily in his

diagnosis, but should pass judgment only after a careful study of the case; for it is hard to force a sick man to duty, but, on the other hand, feigned diseases, which escape detection, are rewards granted to fraud.

Among the diseases most readily and frequently feigned, are pain, rheumatism, deafness, impaired vision, etc.; all of these are as difficult of detection as their simulation is easy, and hence the readiness with which such complaints are feigned. When we are called upon to investigate these suspected cases, we must carefully weigh the moral and physical condition of the patient—his habits, his probable motives, with the presence or absence of pathognomonic symptoms. During the examination we must mark the disposition of such malingerers to overact their part, their anxiety to impress us with the reality and severity of their sufferings, and also the readiness with which they can be led on to acknowledge the presence of incompatible and preposterous symptoms.

When pain is feigned, as this may really exist as a disease without external manifestation, it is the most difficult of all symptoms to detect. By close observation and constant watching the fraud may be detected, although the malingerer may continue his complaints until he attains his object—a discharge from the service. In studying out this imposition, we must examine into the nature and cause of this pain—its duration and intensity—its character, whether fixed or wandering, whether persistent, remitting, or intermitting, and whether increased or diminished by pressure—for no part can be exquisitely sensitive under pressure, which will not show other indications of local trouble. If the patient complains of an internal pain, we should examine whether it be accompanied

by those symptoms which it is impossible to assume, and the absence of which would lead to suspicion.

Much may also be learned from the treatment pursued. In real diseases painful remedies will not be objected to, while in the feigned a decided aversion is shown when the use of these remedies is threatened. I have cured a pain of six months' standing in a malingerer by the use of the actual cautery, and the promise that, if the first application did not remove all the pain, a second would most certainly effect it Even the prospect of a severe application on the following day, if the patient does not feel better, has brought its fruit. This, however, does not always succeed, as malingerers have withstood the repeated application of the most powerful remedies, and have confessed their imposition only after exhausting the resources of the suspecting surgeon, or after obtaining their dismissal. A simple mode of testing the sensitiveness of what the patient complains of as an intense pain, is by making pressure upon the part when the patient sleeps. Sleep, in itself, may lead to detection—as quiet, placid sleep at night, with intense pain during the day, without loss of flesh or general impairment of the digestive organs, are a combination which belongs to no known disease.

The pains complained of by malingerers usually assume the form of a rheumatism, which withstands all treatment. Notwithstanding the liberal use of remedies, this pain continues unmitigated—the patient at all times suffering severely; while the true disease is mostly affected by changes in the weather. Catechising in the feigned disease will readily mislead the patient into acknowledging inconsistent and contradictory symptoms, which, in many cases, will lead

to detection. Intense and long-continued pain in a joint can not exist as an isolated symptom. Walking with a stick, which patients think necessary to influence the medical officer, is an expedient common to all those whose indispositions are less serious than they would have the medical officer believe. Being stunned by a bomb is a piece of good fortune to many, who prefer hospital life to the exposures and privations of the field; and as long as the war lasts there will be some who will have partially-paralyzed limbs and painful spines from this cause. To be "stung by a bung," and be demoralized, is a condition which hospital surgeons classify among the most intractable of diseases.

A feigned paralysis of the arm—a disease at times assumed—can be readily detected during sleep, by tying the sound arm to the body and tickling the nose or lips, when the palsied arm will innocently move to the face to brush away the offending body.

Deafness comes next in order as a disease difficult of detection, and, therefore, frequently assumed. Those familiar with this disease will often notice a peculiar manner, which belongs to such only as have difficulty in hearing. The surgeon must exercise his ingenuity in devising means for exposing the imposition. Among these would be making, suddenly, loud noises, such as discharging a pistol near the ear of the unsuspecting person. Very few have such control over themselves as to withstand this trial, although instances are known where impostors remained unmoved, notwithstanding this test. Relating a conversation in which the patient is deeply interested, and watching clandestinely the play of his features, will, at times, lead to detection.

Chloroform is found a valuable aid in detecting

fraud in those who feign being dumb. An instance has come to my notice of a malingerer who had succeeded repeatedly in eluding the enrolling officer. At last, coming under the inspection of one alive to the frauds practised upon conscripting officers, chloroform was administered, when, under its intoxicating influence, his tongue soon became loose, to the astonishment of his wife, who had not heard the sound of his voice for several years. The loss of voice, when the effects of chloroform had passed off, was readily restored under the bucking process—this severe treatment establishing a complete and permanent cure.

Like impairment in hearing, so is impaired sight a very common complaint among those who desire to escape duty. Night or day blindness is a complaint which may have foundation under certain circumstances, but is rarely met with. When suspicion is aroused, compulsory duty is the best remedy. Under the plea that, for sentinel duty, and especially for night duty, hearing is even more important than seeing—and as four ears are always better than two—a double guard, of which the malingerer is one, should be placed at the post. At the same time, a low diet will show the impostor that his complaint does not meet with much sympathy. A soldier may appear before the medical officer with an excessively dilated pupil, and with a complaint of impaired vision. It must be remembered that, as a disease, this symptom seldom appears alone, and that a drop of a solution of belladonna will, at any time, induce it. Where such a case excites suspicion, searching the patient and locking him up, under guard, will, in a few days, solve the doubts by the return of the pupil to its normal dimensions.

Epilepsy is another disease often attempted. To

have fits is thought by the public to be the acme of an incurable condition, deserving the commiseration of a community; and the soldier necessarily infers that a man who can have a fit while in camp, surrounded by his companions, may have a similar one while on guard duty, and is, therefore, not a proper person to be entrusted with the protection of a camp. These fits are brought on at will. Should the surgeon of a hospital express a desire, in the hearing of the patient, to see him during an attack, he will most likely be accommodated during the day. This disease has been so frequently feigned, both in civil as well as military life, and the symptoms of the disease have been so carefully studied, that most surgeons will be on their guard against such impostors. A drop of turpentine or alcohol in the eye of such an one will, without doing harm, bring his acting to a speedy close. Very few impostors can stand this innocent test. It is, perhaps, as well to state that, during the epileptic fit, all sensibility is for the time suspended, which is not the case, of course, when the disease is feigned.

A feverish skin may also be simulated by the liberal use of a flesh brush, while the foulest coat upon the tongue can be manufactured at will by a local application of chalk, clay, ashes, brick-dust, flour, soap, etc. Deformities and contortions of the limbs, which are never drawn up during sleep, or *under the influence of chloroform*, are also feigned by malingerers, and will require the most careful scrutiny. In order to deceive, the mouth is scarified to permit the spitting of blood, ulcerations on the legs are made by the pressure of hard substances, and swollen arms and legs by ligating the extremities near the trunk. Frequent micturition or diarrhœa may easily be complained of, and dysenteric stools have been actually stolen from neighboring

patients to assist in carrying out the deception. It is only necessary for surgeons to know to what extent diseases may be feigned, to be prepared to meet the impostors; and by using all the means, both morally and medically, which their ingenuity would suggest, to detect and punish the malingerer.

Maiming, or self-mutilation, is occasionally practised in every army by craven, cowardly men, who, in this way, try to escape the dangers or privations of the field. In the English service every soldier maimed by the discharge of his own musket, and who thereby becomes unfit for service, whether the injury occurred on or off duty, or whether accidental or intentional, is, in every case, tried by a distinct court-martial as soon after the event as possible. The soldier's claim to a discharge, or even his exemption from punishment, will depend upon the decision of the court.

APPENDIX.

A FEW PRACTICAL RULES USEFUL IN PERFORMING THE VARIOUS OPERATIONS REQUIRED IN MILITARY SURGERY.

AMPUTATION OF THE FINGER.

Owing to the size of the phalangeal bones composing the finger (plate 2, fig. 1), amputations are usually performed in the joints for any injury which the bones may have sustained, although, under certain circumstances, it may be preferable, when a good flap can be made from the soft parts around the wound, to remove the finger at the point of injury, cutting off the sharp ends of the bone with a bone forceps. This proceeding gives an equally good result with disarticulation. In gunshot wounds of the fingers, as the bone as well as soft parts are usually much crushed by the missile, disarticulations through the joint above the injury are to be preferred.

In examining fig. 1, of plate 2, it will be seen that the phalangeal bones have their extremities enlarged, but, at the same time, so rounded off that when brought in contact with each other a ring of depression exists at the point of apposition. The lateral surfaces of these enlarged heads are roughened and nodulated for the attachment of the lateral ligaments of the joint. These are so prominent, that when the index finger and thumb of the surgeon are made to glide with pressure over the lateral surfaces of a finger from its extremity upward, the contracted shaft of the phalangeal bone is felt enlarging as the joint is approached. Surmounting the first elevation is a line of depression, followed immediately by a second elevation, from which the fingers gradually descend upon the constricted shaft of the superimposed phalanx. Between the two hillocks is the depressed line of the articulation. Another mode of determining the articulating surface is by traction upon the inferior portion of the finger—when, the ends of the bones being drawn apart, the surgeon can insert the nail of his index finger between the separated articulating ends on the dorsal surface of the finger. If much delay has occurred, however, in the presentation of the wounded soldier, the finger may have become so much swollen as to have obscured these prominences and depressions. The natural folds upon the palmar face of the finger can always be used as an in-

fallible guide to the position of the articulating surfaces—plate 2, figs. 1 and 2. Of the three folds, the *middle one corresponds always* with the junction of the first and second phalangeal bones. The fold nearest the end of the finger lies one-eighth of an inch behind the joint of the second and third phalanges, while the upper fold lies half an inch in front of the articulation of the finger with the palm of the hand. If it be remembered, in connection with these landmarks, that when any of the hinge-joints are flexed at right angles, the antero-posterior diameter of the lower head of the upper bone forms the prominent angle, and, if allowances be made for its width, the articulating surfaces anterior to it will be readily found. In performing amputations of the fingers, the sharp-pointed bistoury, found in all pocket-cases of instruments, is the knife preferred.

Amputation of a part of a Finger.—In amputating at the second or third phalangeal articulation, either the circular or flap operation may be used, and the latter either by transfixion or by cutting the flaps from without. The plan generally adopted is that of making an anterior flap from the palmar surface, as in plate 2, fig. 5, by transfixing, with a sharp-pointed bistoury, the finger on a level with the articulation, including in the flap about being formed half the soft parts comprising the finger. This is accomplished by entering the point of the knife from the side of the finger in such a way as to strike the lateral surface of the phalanx; the handle being now depressed, allows the point to glide over the bone, when it should be in turn elevated so that the point will protrude opposite to its place of entrance. The blade is now, by a sawing motion, made to graze the bone in its descent for the distance of half or three-quarters of an inch, when the blade is made to cut directly out at right angles to its former course, which completes the flap. The hand is now turned over to its dorsal aspect, and the skin of the finger upon which the amputation is being performed being well drawn upward by an assistant, the position of the joint having been satisfactorily located, an incision is made at right angles to the flap, which will join the incisions on each side of the finger, and, at the same time, expose the articulation. The lateral ligaments form the key to the joint, and keep the extremities of the phalanges in close apposition. Until these are divided, which should be effected by the point of the knife, the articulation can not be traversed.

This amputation may be modified in the following way: After making the palmar flap, this might be raised by an assistant (plate 11, fig. 6), and the joint entered from the palmar surface. Unless the operator is well skilled in anatomy and in the operative manual, the articulation will not be easily found, as the configuration of the parts will most probably throw the knife above the joint upon the shaft of the superior pha-

lanx. The steps of this amputation may be reversed—the articulation entered from the dorsal surface, as seen in plate 2, fig. 3, and, after the division of the dorsal and lateral ligaments, the finger being bent, the blade traverses the joint, and then has its position changed to one of right angles to its former course—fig. 4. The finger is now extended, and the palmar flap cut as before directed. The arteries being very small, do not require, usually, a ligature; twisting them with a torsion forceps will, as a rule, prevent hemorrhage. Should they bleed, however, they should be ligated. The flap, which should be made always long enough to cover completely the exposed articulating surface, will be adjusted by two or three points of suture, and the application of a single thickness of wet cloth completes the dressing. The adhesive plaster dressing, which was the old method of putting up stumps before water dressing came into vogue, would, when wet, become detached, and permit the wound to gape, which, in itself, would destroy all hope of union by the first intention. The sutures should be removed on the fifth day. The wet cloth will be continued for a few days longer, when simple cerate dressing should be substituted. All the advantages of cold water dressing, which are chiefly to prevent inflammation and promote quick union, will be obtained within ten days, when its use should be discontinued. When used it should be applied to the stump alone, and not to the entire extremity. Cold water dressing, although essential in the treatment of wounds, like every good remedy, is liable to much abuse. Its diffused application, and the extravagant waste of cloth, extending over an entire limb for a circumscribed wound, can not be too severely criticised.

During the inflammatory stage of reaction, extending over the first five or six days succeeding an amputation, cold water should be freely used; but when this period has passed, a damp cloth, renewed before it becomes dry, is the proper dressing; otherwise, an inflammation of the skin is set up, with the formation of itching pustules, which are more annoying to the patient than the wound for which the water treatment is used.

Amputation of a Finger.—In removing an entire finger at the metacarpo-phalangeal articulation, one of two methods are usually adopted: either by the oval method, or by lateral flaps—plate 2, fig. 7. The articulating surface will be located as directed above for the phalangeal joints, but more especially by traction upon the finger, which will separate the extremities of the bones to a considerable extent. The incision must be commenced upon the back of the hand, over and upon the metacarpal bone, and at least half an inch above its inferior extremity. This is continued parallel with the bone until it reaches the articulation, when its direction is obliquely changed, passing midway

between the fingers to the extremity of the webbed portion of skin. If the oval method has been selected, the knife is now made to encircle the palmar face of the finger in the upper fold of skin indicating the junction of the finger and hand, and is then brought up upon the opposite side of the finger; when reaching the web of skin its direction is changed to make an oblique incision similar to the one first traced, and which will meet this on a level with the joint—not, therefore, where the incision started from, but half an inch below it. If the incision was continued upwards to end where it was commenced, a V flap of skin would be removed, which would leave a deficiency of soft parts for covering the exposed end of the metacarpal bone.

If the flap operation has been preferred, the direction of the knife is changed after reaching the webbed portion of skin before spoken of, and instead of encircling the palmar surface of the finger, it follows an oblique course in the palm corresponding to and directly under the oblique dorsal incision. When the point of the knife reaches the palmar site of the joint, which will make an incision three-quarters of an inch in length and terminating one-third of an inch from the transverse fold in the palm of the hand, its direction is changed, so as in cutting out to make an equally oblique incision, passing through the webbed skin upon the opposite side of the finger to be amputated, and continuing obliquely upon the back of the hand to meet the first incision over the articulating surface.

The flaps are now dissected upward, in order to isolate them from the finger, which is drawn upon and flexed at right angles, so as to facilitate the disarticulation, which can now be readily effected by dividing the extensor tendon and dorsal ligament, then the lateral ligaments which form the key to the joint, and finally the palmar ligament with flexor tendons. In all hinge-joints the bones are kept in close apposition by these lateral ligaments, and to facilitate their division it is necessary to put them upon the stretch by flexing the bone laterally. The two small arteries which run parallel on either side of the head of the metacarpal bone will require ligation, otherwise annoying hemorrhage will probably occur, necessitating the opening of the stump. To avoid complicating the wound with too many foreign bodies, one end of the ligature should be cut off near the knot, and the other, drawn out from the most convenient portion of the wound, is confined about one inch above the stump, under a strip of adhesive plaster. Three or four stitches will keep the flaps in close apposition, and a single thickness of wet cloth completes the dressing.

Amputation of all the Fingers.—When a gunshot wound has so crushed all of the fingers as to necessitate the removal of all of them, the flap to cover the heads of the metacarpal bones must be made from

the palm, and also a small flap from the dorsal skin to assist in covering over these large bones. The site of the articulations being readily determined, the operator commences the palmar incision, if he is operating upon the right hand, by inserting the point of the knife through the skin upon the lateral surface of the joint of the index finger, midway between the palmar fold and the fold at the base of the finger. From this point he traces a curved incision across the junction of the fingers with the palm, extending to a similar point upon the outer side of the little finger, having traversed the palm one line above the interdigital web. The object, at this step of the amputation, being simply to trace out the form of the flap, the knife only traverses the thickness of the skin.

The hand is now reversed; and while an assistant retracts the skin, as seen in plate 3, fig. 2, a similar incision is marked out on the dorsal surface, extending also in an elliptic form from the outer to the inner termini of the palmar flap, and from one-fourth to one-third of an inch below the joints—which is as deep as a regularly delineated flap can be made, owing to the skin dipping down between the fingers. This anterior flap, which is the least vascular, is now rapidly dissected up, the joints opened from their dorsal surface, the long-bladed knife passed through and under them, and a flap cut out, following the line which was marked out in the palm. The arteries having been ligated as they are exposed between each metacarpal bone, the flaps are brought together by means of five or six points of suture, which, by their nice adjustment, will give an excellent result.

The assistant who holds the hand for the surgeon can assist materially in the successful accomplishment of the amputation by handling the limb in the following manner: The hand to be operated upon being pronated with the dorsal surface upwards, the assistant places his two hands on each side, with the ends of the second, third, and fourth fingers of each hand resting over the course of and compressing the radial and ulnar vessels; the patient's wrist is clasped by the balls of the assistant's thumbs—which are the supporting power upon the back of the wrist, and against which pressure is made by the fingers resting over the arteries. The two index fingers make tense the skin of the palm of the hand, while the thumbs of the assistant make traction upon the skin of the dorsal surface, which enables the surgeon to include all the skin possible in the posterior flap. Without shifting his grasp the assistant can pronate or supinate the hand as the surgeon requires, in the various steps of the amputation. This is a good method of securing the hand during all operations upon this extremity.

Amputation of Finger, with Metacarpal Bone.—When necessary to remove a portion of, or the entire metacarpal bone, similar meth-

ods of operation may be adopted as in the removal of a finger, selecting either the oval method, or lateral flap, according to the character of the injury or the fancy of the surgeon. Plate 2, fig. 8, indicates how the oval method should be carried out. When the entire finger requires removal, the point of the knife should commence to trace the incision over the carpal bone to which the finger is attached. For the thumb the incision, commencing over and upon the trapezium bone, passes downwards upon and parallel with the metacarpal bone for half its length, when its direction is changed obliquely, so as to pass around the finger, as in plate 2, fig. 8. When the soft parts are separated from the bone, as in plate 2, fig. 9, the thumb is forcibly flexed into the palm, which makes prominent the head of the bone and stretches the ligaments. With the point of the knife both the posterior and lateral ligaments are divided, which allows the bone to be lifted up, the knife passed under it, and the finger detached. The stump is well shown in plate 2, fig. 10.

The only difference between removing one of the middle fingers, or with it the metacarpal bone in part or in whole, is in the length of the perpendicular incision. In the flap operation, which is preferred by many for the little finger or thumb, the lateral flap is defined by placing the point of the knife (plate 3, fig. 1) over the articulation of the carpus with the metacarpal bone on the back of the hand, tracing an incision upon and parallel with the metacarpal bone over its entire length. When it has passed the level of the metacarpo-digital articulation it turns off obliquely to the outer side of the finger, continuing downwards to the middle of the first phalanx, or to a level with the extremity of the interdigital web; the point of the knife is then reversed, and an incision, corresponding exactly to that upon the back of the hand, is traced in the palm. In these lines a broad outer flap is dissected up.

The skin of the hand being now drawn inwards by an assistant, the knife, with its edge against the web, is placed between the finger to be operated upon and its neighbor, and, by a sawing movement, is made to traverse from below upwards, the intermetacarpal space meeting the first incisions where the metacarpal bone joins the carpus. The finger is now forcibly drawn outward, which puts the carpo-metacarpal ligaments upon the stretch, and facilitates their division from within outwards. When the head of the bone is liberated the knife is passed upon its outer side, and, by cutting from above downwards, the soft parts are severed from the metacarpal bone in the lines of incision, and the flap completed. When the arteries are ligated and the flap secured in its position by several points of suture, very little deformity will be observed.

AMPUTATION OF THE HAND.

Partial amputation of hand.—In injuries to the hand the surgeon must ever remember that every portion of this extremity which can be saved can be made useful; and the thumb alone, when opposed to even a portion of the palmar surface, will prove far more useful than the most elaborate artificial limb. Therefore, should the hand be ever so much crushed by shell or shot, if the thumb and one or more fingers can be retained, it is the duty of the surgeon so to improvise an operation as to remove only those portions which extended experience has shown can not be saved. Experience has established the fact that frightful mutilations are not incompatible with the restoration of a useful member; therefore we must not be guided by appearances in condemning a hand. If two or three fingers, with their metacarpal bones, have been crushed, with soft parts torn, and bones protruding, such fingers alone should be amputated. If all the metacarpal bones of the palm have been crushed, with frightful laceration of the soft parts, it may still be possible to saw through the metacarpal bones immediately above their broken, spiculated surfaces, which is a better operation, when we have the choice, than disarticulating in the carpo-metacarpal joint—plate 3, fig. 5. In performing this amputation the flap is made, as usual, from the palmar surface, either by marking with the point of the knife the form and size of the flap desired, and then dissecting it from without inwards, or, having mapped out its extent, cutting it up rapidly by transfixion—plate 3, fig. 6.

In amputating the right hand, the point of the knife perforates over the unciform bone, and, after traversing the entire palm, appears at the root of the thumb at a point where its web joins the lateral surface of the hand. With a sawing motion the heel of the knife cuts out the flap by following the line which had been previously traced, *c b a*, in plate 3, fig. 6. The hand is then reversed (figure 5) and an incision made on a level with the carpo-metacarpal joint, extending on the back of the hand from its outer border to the head of the metacarpal bone of the thumb, *a* to *b*—then obliquely downwards through the interspace *b c*, between the metacarpal bones of the thumb and index finger, to meet the commencement of the palmar incision. The hand is then forcibly flexed, the point of the knife dividing the posterior carpal ligaments and opening the joints, the line of which can be determined by per landmarks—one, the head of the metacarpal bone of the thumb, and the other the prominence of the cuneiform bone on the outer border of the hand; just below this prominence is the articulation of the fourth and fifth metacarpal bones with the unciform bone of the carpus. As the large vessels supplying the hand run through the palm, the loss of much blood during the amputation can be avoided by making first the posterior in-

cisions, then completing the division of the ligaments, and opening the joint before the palmar flap is dissected up. Complete the operation by ligating every bleeding vessel, and retain the flap in thorough apposition by using a sufficient number of sutures.

AMPUTATION AT THE WRIST-JOINT.—The hand is, however, so mutilated at times, from the effect of shot or shell wounds, that it is impossible to save it, and its entire removal is demanded. Under such circumstances disarticulation at the radio-carpal joint may be performed, either by dissecting up a circular flap of skin, or by making a palmar flap. Commencing the circular incision an inch below the styloid processes of the radius and ulna, which form easily-felt prominences on each side of the wrist-joint, dissecting up the skin alone, a flap is made, which is turned up over the lower part of the arm as the cuff to a sleeve. When dissected up to the level of the joint, which is recognized by the styloid processes, the tendons on the back of the hand are divided by a sawing motion of the knife, also the capsule, which is very thin, and the joint is thus opened from behind. The division of the lateral ligaments and flexor tendons complete the operation. The prominent ends of the radius and ulna should be removed with the saw before the flap is closed by suture; as, otherwise, these projections of bone, compressing the sensitive skin of the flap, leave sore points for some time after the wound has completely cicatrized, or, by their pressure, may cause ulceration through the skin. The radial and ulnar arteries, which will require ligation after this amputation, will be found on the outer and upper sides of their respective bones.

The flap operation which gives the most perfect adaptation of the soft parts over the ends of the bones, is performed as follows: With the palm of the hand upwards, the point of the knife is made to perforate the skin on the lateral surface of the hand immediately under the styloid process of the radius; from which point (plate 3, fig. 8) an incision descends for three-quarters of an inch, then sweeps n a semicircular direction across the palm one and a half inches be ow the joint, to terminate in a perpendicular incision of three-quarters of an inch under the styloid process of the ulna. The styloid process of the radius is felt as a prominence on the outer side of the wrist-joint and continuous with the shaft of the radius, the styloid process of the ulna being on the inner side and continuous with the ulna bone. A slightly concave incision (concavity looking toward the hand), into which the convexity of the palmar flap will be nicely adjusted, is now made over the back of the joint (plate 3, fig. 8), connecting the styloid incisions. With a sawing movement of the knife the tendons on the back of the hand are divided, and the articulation widely opened. The lateral ligaments being severed, the amputation is completed by push-

ing the blade of the knife through the joint and under the bones, when a palmar flap is dissected out in the line of incision previously traced.

AMPUTATION OF THE FOREARM.

Several methods of amputating the arm may be adopted where the radius and ulna have been crushed, with extensive injury of the soft parts, viz: the circular amputation, a double flap, or a long anterior flap, sufficient to form a good stump—the rule in this, as in all amputations, being to leave the greatest length of limb possible.

Circular method.—Although the circular amputation can be applied to every portion of both extremities, there are certain portions of the limb where other methods are preferable. Such is the case where an amputation is demanded upon the lower portion of the arm, where, the limb being conical, the lower border of the flap is everted over the larger portion of the limb. As the skin is, however, very elastic, this can be effected without much effort. A circular incision is made around the arm, extending alone through the skin (plate 5, fig. 2)—the object being to avoid injuring the deep vessels of the limb at this stage of the amputation, and thus save the patient the loss of blood which he would otherwise incur. This skin is then dissected up from the muscles, and, when separated sufficiently, is turned over as the cuff of a coat would be, when its isolation can be the more readily effected by drawing the sharp edge of the knife upon the bands of cellular tissue which tie down the skin to the deeper tissues, until a sufficiency of flap is obtained. The incision through the skin is always located in reference to the point where it is desired to divide the bones, the proper allowance being made for the size of the limb. If the limb is to be removed a few inches above the wrist, the circular incision through the skin would be located one and a half inches below the point at which the bones are to be sawed. In the more fleshy portions of the arm, nearer the elbow, from two to two and a half inches of skin would be required.

The circular flap being well drawn upwards by an assistant, the knife is made to encircle the limb immediately below the fold of turned-up skin, and, cutting to the bone, divides all of the muscles. The point of the knife is then thrust between the radius and ulna to divide the interosseous ligament and such muscular fibres as may have previously escaped the knife. When the bones are isolated, a retractor, made by slitting three tails in a band eight inches wide, is applied for the protection of the soft parts. The middle tail is placed between the bones, the lat-

eral and broadest tail on each side of the bones, and all drawn forcibly upwards, retracting and protecting the soft parts for the formation of the stump (plate 1, fig. 1). The saw is applied to the bones just below the retractor. In its application, place the heel of the saw upon the ulna (which is the immovable bone of the forearm), and fixing it in position between the stump and the thumb-nail of the left hand of the operator, he draws the saw backwards, which at once makes a groove for itself, and prevents the instrument wandering about the limb, jeopardizing the fingers of surgeon and assistant. As soon as the saw has made a way for itself, its position is so changed as to make it complete the section of the radius (the rotating, movable bone) before the section of the ulna is finished. Ligate the vessels, usually two in number, the radial and ulnar artery—although, at times, two others, the anterior and posterior interosseous, may require ligation. Cut off one end of each ligature near the knot, and bring the other carefully from the wound, securing all the remaining ends under a piece of adhesive plaster upon the arm; then apply so many points of suture as will keep the opposing edges of the circular flap in perfect apposition. A wet cloth over the stump completes the dressing.

Flap operation—(Plate 5, fig. 3.)—Amputating the arm by one or more flaps is an operation at times preferred, from the rapidity of its execution; or when, from extensive injury to the soft parts upon one side of the fractured bones, without wound on the other, a single flap made upon the uninjured side of the arm would enable the operator to amputate lower down, thus saving more of the extremity. Transfixion is the preferable mode of forming the flaps. The arm having been supinated so that the radius and ulna lie parallel to each other—a very necessary step, to avoid passing the knife between the bones, which would be a most awkward accident for the surgeon who values his reputation—the operator, if operating upon the left arm, seizes all the soft parts in front of the bones with his left hand, while he passes the point of the knife through the skin on the outer side of the arm down to the outer edge of the radius, which is fairly struck by its point; the handle of the knife is then depressed, so as to elevate the point and allow it to glide upwards over the upper edge of the bone. As soon as the point of the knife escapes beyond the margin of the radius its handle is brought to the first position, so as to allow the blade of the knife to glide over the anterior surface of both radius and ulna, grazing these bones. When over the ulna, the handle of the knife should be elevated, which will depress the point; the soft tissues over the blade are drawn upwards, and the knife now made to transfix the skin on the inner side of the arm, on a level with the inner border of the ulna, so that at least one-half the thickness of the soft parts of the arm will be

over the blade. The knife is now made to graze the bones in its descent for two inches, when the edge is turned directly upwards nearly at right angles with its former course, and, by a *sawing motion*, cuts its way outwards through the tendons and skin. The anterior flap being thus formed, the knife is made to transfix the limb at the point where the operation was commenced (plate 5, fig. 3). Passing now behind the bones, the soft parts on the back of the arm being drawn backwards, so that the blade may readily transfix the arm without cutting again the skin, the knife is made to graze the posterior surface of the bones for the space of two inches in its descent, and cuts out again at right angles, with a sawing motion, to form the posterior flap.

The two flaps are now elevated by an assistant, while the surgeon passes the knife around the limb on a level with the base of the flaps, which enables him to divide the remaining muscular fibres directly upon the bones. He also passes the knife between the bones for the purpose of dividing the interosseous membrane and the muscles attached to it. To perform this step of the operation successfully, the point of the knife must be thrust from below upwards, and the edge, in turn, be brought, with a sawing motion, against both radius and ulna. When withdrawn, the point of the knife is, in a similar manner, inserted from above, with the same object in view. The flaps are now well drawn back by an assistant, who clasps the arm and everted flaps with both hands near the point where the bones are to be divided. If the assistant is unskilled the soft parts can be well protected from injury while sawing, by using a retractor or piece of cloth fifteen inches long and twelve inches wide. One end of this is torn, half-way down, into three strips, the central one of which is but one and a half inches wide. This central strip is thrust between the bones, the broad pieces are brought up on either side and drawn obliquely over the anterior face of the flaps and forearm, which, when drawn firmly up, encloses all of the soft parts in a kind of bag, thus protecting them from being injured by the saw.

The soft parts which are to compose the stump being now well protected, the operator places the heel of the saw upon the ulna, fixes it in its position by the nail of his thumb, which rests against the side of the blade and prevents it from wandering, and drawing the saw backwards nearly the entire length of the blade, makes a groove for its reception. When this groove is sufficiently deepened by the to and fro movements of the saw, which is permitted to cut chiefly by its own weight and with but little pressure from the surgeon, the handle is so depressed as to allow the saw to groove the radius, which, as a movable bone, should be first divided before the ulna is severed. If the arm, both above and below the point of amputation, is firmly held, and the saw allowed to run easily with but little pressure, the bones will be smoothly cut. Any

motions allowed in the arm, particularly if one portion of the arm is tilted upwards, or overpressure made upon the saw, will cause the blade to be caught between the bones, or cause the bones to snap before the division by the saw has been completed, leaving an ugly, sharp spiculum projecting from the extremity of the bone, which must be removed by the bone forceps. If this sharp point be left it will irritate the flaps, may cause ulceration, and, protruding through the soft parts, be the source of long-continued pain in the stump. Two large arteries will require ligation in the anterior flap—plate 5, fig. 4—lying respectively over the radius and ulna bones. A third, and even a fourth, much smaller vessel, which sometimes requires tying, will be found between the bones and upon either side of the interosseous membrane. All the vessels are secured by the assistance of a tenaculum or a bull-dog forceps. This forceps differs from the torsion or dissecting forceps in having the ends shaped like the beak of a sparrow, and so conical that it is impossible for the noose of the ligature to remain upon it. When the ligature is drawn upon, it must slip off the instrument upon the artery held between its points. One end of the ligatures is cut off near the knot; the other is brought out of one of the angles of the wound, and secured upon the arm by a strip of adhesive plaster. The flaps are brought together by several points of interrupted suture.

One of the established rules in surgery is always to operate as far from the trunk as possible, compatible with the removal of all of the diseased tissues. As military surgery offers no exception to this rule, cases frequently occur requiring amputation in which the injury is confined altogether to one side of a limb. In such cases, if the crushing of the bones does not extend beyond the immediate seat of injury, it is good surgery to cut a long flap from the uninjured side of the member and amputate just above the fracture, making upon the injured side of the limb a semicircular incision, joining the flap at right angles. It will be most convenient to make this flap by transfixion, taking the precaution, as related above, of including half the thickness of the soft parts of the limb in the flap.

AMPUTATION AT ELBOW-JOINT.

In disarticulating at the elbow-joint, the anatomy of the osseous surfaces entering into the formation of this articulation must be familiarly known, otherwise great difficulty will be found in getting between the bones. In examining plate 4, fig's 1, 2, 3, the forms of the heads of the radius, ulna, and humerus can be studied in detail, isolated as well as in juxtaposition, with their lateral as well as antero-posterior rela-

tions. It must be remembered that the shaft of the humerus, as it becomes developed to form the head, not only expands its surface, but is also surrounded by important prominences placed laterally upon enlargements which are called condyles. The outer elevation, called epicondyle, is the conspicuous prominence visible on the outside of the elbow, and separated from the articulation of the radius with the external condyle about half an inch—plate 4, fig. 3. The external lateral ligament which assists in forming the elbow-joint, is attached above to this epicondyle, below to the head of the radius, or rather to the annular ligament which binds together the radius and ulna. The epitrochlœa, a larger and more prominent elevation, situated upon the lateral surface of the internal condyle, is in a similar way related to the ulna, giving attachment to the powerful internal lateral ligament which connects this epitrochlœa to the inner face of the head of the ulna, and distant from the articular face about three-quarters of an inch.

The articular face of the humerus (plate 4, fig. 1) presents two unequal prominences; upon the smaller or outer one rotates the cupped head of the radius, while upon the larger or inner one the head of the ulna, with its anterior sharp coranoid and long posterior olecranon processes, moves as upon a pulley. To receive these prominent processes of the head of the ulna are two depressions upon the anterior and posterior surfaces of this extremity of the humerus, called sigmoid fossæ, which permit the extended movements of flexion and extension. When the bones are placed in their proper position it will be found that, although the epicondyle and epitrochlœa are upon the same plane, the line of the articulation runs obliquely inward and downward (plate 4, fig. 3); the anterior line of articulation being overhung by the coranoid process of the ulna (plate 4, fig. 2), while the posterior surface is completely covered in by the projecting olecranon process of the same bone. The main artery runs in front of the joint. In amputating by the anterior flap, which is preferred by some to the circular operation, the arm is supinated and slightly flexed (plate 4, fig. 4); the surgeon, standing upon the inner side of the limb, and using a long narrow-bladed knife, transfixes the limb by introducing the point on the inner side of the arm, one and a half inches below the epitrochlœa or prominence on the inner condyle of the humerus. In its passage forwards the point of the knife strikes the side of the ulna. The handle is now depressed to allow the blade to glide over the anterior face of the bones, when the handle is again elevated to allow the point to protrude on the outer side of the arm, one inch below the epicondyle or prominence on the outer condyle of the humerus. A flap is made by a sawing motion in the descent of the knife, the blade grazing the bones in its downward movements, until four inches is traversed, when it is turned directly outwards and the flap completed. In

transfixing the arm for this flap, unless the bones are kept parallel by placing the forearm in supination, the point of the knife may pass between the bones—a very awkward accident. As an assistant elevates the flap, he at the same time compresses the main arteries which traverse it, controlling the hemorrhage. If the skin be properly retracted by an assistant, the points at which the knife transfixed the arm will have been drawn up, corresponding closely to the articulating surfaces (plate 5, fig. 5), viz: half an inch below the epicondyle and three-quarters of an inch below the epitrochlœa. The round head of the radius being clearly distinguished, the operator, stooping, with his hand under the arm to be removed, places the heel of the knife at the outer angle of the incision, and with a sawing motion makes a semicircular cut around the back of the arm, terminating at the points of transfixion. In dividing the skin at this step of the operation, if the surgeon has marked well the osseous prominences, the blade of the knife should be made to glide between the head of the radius and the condyle of the humerus. The articulation of the ulna with humerus is now attacked from in front, by the division of the remaining muscular fibres not severed in making the flap, and also by the division of the internal and anterior ligaments, which are put upon the stretch by extending forcibly the forearm. Should there be any difficulty in finding the situation of these ligaments, it is only necessary to refer to the epitrochlœa; three-quarters of an inch below it the articulation will always be found. The articulation having been largely opened in front, continued forced extension will luxate the olecranon process from its deep sigmoid fossa, when the triceps muscle attached to this prominence should be cut off close to the bone, and the forearm removed in the line of incision already traced on the back of the arm. The radial and ulna arteries and, perhaps, also the interosseous, will require ligation. The ligatures are brought out at one of the angles of the wound, and the flap secured in its position by several points of suture. A single thickness of wet cloth over the stump completes the dressing.

The circular amputation at the elbow-joint is an operation which gives equally good results with that of the anterior flap. The arm is held in supination and slightly flexed, and the brachial or axillary artery secured by pressure with the fingers, either in the axillary space at the junction of the anterior with the middle third of this space, in which line the axillary artery can always be found running directly over the head of the humerus, and at which point, owing to its superficial seat being covered only by skin and cellular tissue, and lying upon bone, the circulation through it can be most readily controlled; or, as the vessel courses through the arm on the inner side of the biceps

muscle, where it is readily felt, surrounded by its veins and accompanying nerves. If an intelligent assistant is at hand, the artery can be readily secured in either position. Should it be necessary, however, to use the tourniquet, this can only be applied upon the arm about its middle and over the inner border of the biceps muscle. The test of the proper application of the tourniquet will be the complete control of the circulation, with cessation of the pulse at the wrist. As the tourniquet in general use clasps the entire limb so tightly as to stop both arterial and venous circulation, deep-seated as well as superficial, much blood is usually removed in the limb. The fingers of a good assistant, which is in every case to be preferred, will only compress the limb at two points: one over the seat of the vessel, and a point of counter-pressure upon the opposite side of the limb. As this methodical pressure does not embarrass to any great extent the venous circulation, the blood, which otherwise would be incarcerated in the condemned member, has an opportunity to escape, and the amputation will be effected with very little loss.

The circular operation is commenced by the surgeon in a kneeling posture, passing the knife under the arm, so as to make an incision on the outer and upper part of the arm, three fingers' breadth from the fold of the elbow. By a sawing motion a circular line is traced on the outer, under, and inner side of the arm, the operator rising from the kneeling posture, which enables him to watch the heel of the blade, and direct properly the line of incision. As it would strain the wrist to perfect the incision on the upper surface of the arm, it is preferable, although not so brilliant a step in the process, to change now the position of the knife, and, placing the blade over the arm in the incision where first commenced, complete it by cutting toward the operator, thus joining the two terminations of the first incision.

Although this incision should extend solely through the skin and cellular tissue, however sharp the blade may be, unless the operator applies a sawing motion to the knife the skin will be very irregularly divided, and at points not cut at all. As the vessels are deeply seated, and the skin alone is required to form the flap, the incision should be only skin-deep, so as to avoid the loss of blood during the tedious process of dissecting up the circular flap. When the circular incision has been completed the operator seizes the upper edge of the incision with a forceps, and by successive strokes of the knife—using a scalpel, if he prefers it to the amputating knife—divides the cellular bands uniting the skin to the deeper tissues. When the skin has been sufficiently undermined, the flap is everted and rapidly dissected upwards until sufficient skin is obtained to cover the head of the humerus, which will bring the flap on a level with the articulation. By a bold sweep of the knife (plate 4, fig. 6) all the muscles are divided, the blade passing between

the head of the humerus and radius, the articulation opened from the front. and the operation completed by isolating the olecranon.

AMPUTATION OF THE ARM.

In amputating the arm in either its upper, middle, or lower third, any one of the various described methods may be used with equally good results. It would be useless here to describe again the circular operation, or dissecting up of a circular flap of skin with which to form a stump, as this operation upon the arm would differ in no respect, except in situation, from that performed upon the forearm, and which has been already so minutely detailed. The circular amputation, upon whatever portion of a limb performed, presents a striking uniformity in its procedure. The skin should always be divided sufficiently below the point where it is designed to saw the bones, so as to allow an ample covering of soft tissues for the extremity. A good rule would be to make the distance between the incision in the skin and the point of division in the bone, or removal at the joint, equivalent to half the diameter of the limb, allowing, in addition, from one-half to one inch for retraction of the skin: *e. g.*, if an arm is four inches in diameter, the incision through the skin should be from two and a half to three inches below the point where the bone will be divided. According to this rule, if a thigh is six inches in diameter the skin will be divided four inches below the point of amputation. By following this rule a sufficiency of skin will be had for covering the stump, permitting ready adjustment without traction upon the sutures used in closing the wound.

A modification of the circular operation, well adapted to the arm or thigh, where a single bone is surrounded on all sides by muscular envelopes, has for its object the formation of a muscular cushion for the immediate covering of the sawed surface of the bone, and is thought by many operators to form a more symmetrical stump than where the bone is covered solely by skin. Before chloroform was used, an additional recommendation was rapidity in its performance; but as a surgeon should never operate against time, a few seconds more or less in completing an amputation, under chloroform, is an item not worthy of consideration. The arm being drawn out at right angles to the body, an assistant compresses the axillary artery as it courses over the head of the humerus, and another clasps the arm above the point where the incision is to be made, at the same time retracting evenly the skin. The surgeon, placed upon the inner side of the arm if he is operating upon the right arm, or on the outer side if the left, stooping or kneeling, as

most convenient, with his arm passed under the arm to be removed, places the heel of the knife on the upper surface of the arm, its point reaching over his shoulder, and with a rapid sawing motion sweeps around the arm, completing a circular incision which extends through the entire thickness of skin.

The watchful assistant at once retracts evenly the skin to the extent of nearly an inch, and the surgeon, placing the heel of the knife in the position where he commenced the operation on the upper surface of the arm and at the edge of the retracted skin, makes a second circular sweep over the limb, passing now through all of the tissues down to the bone. The assistant, placing his fingers deeper into the wound, retracts to a much greater extent the skin, with superficial muscles, when the surgeon places, for the third time, the heel of the knife on the upper side of the arm, upon the level of the retracted edge of the skin (plate 5, fig. 5), and incises again the muscles directly to the bone, dividing carefully all the muscular fibres. A retractor, or piece of cloth twelve inches wide, slit from one end half-way down, so as to make a double-tail bandage, is passed around the bone, the soft parts retracted by it, so as to avoid any laceration of these muscles with the saw, and the bone sawed off as near the retracted soft parts as possible.

Plate 5, fig. 6, shows the relation which the end of the bone bears to the soft envelopes forming the stump, and shows how well and perfectly it is embedded in the muscular layer, and how completely the flap of skin is protected from the sharp edges of the bone. In the amputation of the arm the brachial artery is the only large vessel requiring a ligature, and is found always on the inner side of the humerus, lying obliquely inward and upward.

In amputating the arm by the double flap, the surgeon reverses his position, so that he can seize with his left hand the tissues from which he designs cutting the flap, and, by drawing upward the soft parts of the arm, he can so transfix the limb with the knife as to have fully one-half the thickness of the limb in the first flap. The limb is so transfixed as to form an outer flap, and thus avoid the humeral artery, the division of which should be left for the second or inner flap. The left hand of the operator retains its position, holding upward the fleshy part of the arm, until he has made an incision parallel with the arm, as long as half the diameter of the limb, when he cuts directly outward, liberating the flap. He now, with his left hand, draws the remaining tissues downward, so that the knife may readily pass under the bone, through the muscles, at the point where the arm was first transfixed, without notching or in any way involving a second time the skin. An incision is made, in the descent of the knife, of similar length to that on the upper side of the bone, when the edge of the knife is turned outward, and the skin divided to complete the lower or inner flap. These

flaps are now drawn backward by an assistant: the surgeon sweeps the knife around the bone at the base of the flaps, so as to divide all the remaining muscular fibres which had not been included in the former incisions. While the flaps are now carefully drawn backward, being clasped by both the hands of an assistant, or a retractor with two tails used for the protection of the flaps, the surgeon divides the bone with the saw, having fixed the blade upon the humerus by supporting it with the nail of his thumb. When the limb has been removed, any spicula of bone left protruding from the humerus must be nipped off with the bone-pliers. The brachial artery is drawn out by the tenaculum or forceps, isolated from its accompanying veins and nerves, and tied with a well-waxed thread, before the assistant relaxes pressure upon the axillary vessel. Any vessels which throw a jet of blood, however small, should be ligated, one end of the ligature cut off, and the other brought out of one of the angles of the wound, and secured from injury two inches above the incision, under a piece of adhesive plaster. The wound is closed, as in all stumps, by several points of suture, which should include the entire thickness of skin, but not the muscles. Plate 5, fig. 7, shows the formation of the outer and inner flaps, with the relative position of the bone, forming the apex of a triangle.

AMPUTATION AT THE SHOULDER-JOINT.

In cases where the humerus has been shattered within two inches of the glenoid cavity, without involving the head of the bone in the injury, or in any way implicating the joint, surgeons prefer amputating the limb without removing the head of the bone. By sawing through the humerus just above its fractured seat, the amputation is simplified, both as to the operation and its results, while the rotundity and symmetry of the shoulder is retained. If, however, the injury to the bone extends into the joint, while at the same time the soft parts are so lacerated as to preclude the possibility of resecting the head of the humerus, then disarticulation must be resorted to, in order to save life at the expense of the limb. The shoulder-joint is formed by the scapula and humerus, and protected above by the clavicle. Plate 6, fig. 1, indicates how the round head of the humerus is received into the flat, saucer-shaped head of the scapula, in contact with which it is retained more by the scapula muscle, attached to the greater and lesser tuberosities of the humerus, than by the capsular ligament. The acromial process of the scapula, with clavicle attached (plate 5, fig. 2), protects the articulation from above, while the coranoid process, jutting from the base of the glenoid cavity, protects the joint from within.

Two methods are equally applicable for this disarticulation: a double flap operation, generally known as Lisfranc's, and the oval method, or **Larrey's process.**

Lisfranc's, or the lateral flap amputation at the shoulder-joint.—The patient having been chloroformed and brought to the edge of the bed, the surgeon, having located with care the space between the coranoid and accromial processes, seizes the arm firmly in his left hand, and carrying it upward and outward, if it be the left arm requiring removal, passes the point of a long, narrow, sharp knife (plate 6, fig. 3) into the middle of the posterior fold of the axilla, and pressing it obliquely upward, makes it strike fairly the head of the humerus. By depressing the handle of the knife, the point of the blade is made to glide over the head of the humerus, cutting through the capsule, and continuing onward, between the head and the accromial process, perforates the skin upon the anterior portion of the arm, through the space bounded by the clavicle with coranoid and accromial processes of the scapula. Should it be the right arm requiring removal, this step of the operation is reversed—the knife entering in this triangular space, and after passing through the capsule and over the anterior face of the head of the bone, appears through the posterior fold of the axilla. The deltoid muscle being still relaxed, the point of the knife descends in the line, *a b*, until the blade is brought to a horizontal position, when it completes an outer flap from four to five inches long, in the line of incision, *a b c*. This flap is at once drawn up by the assistant; and as there are no important vessels in it, but little bleeding occurs.

The position of the arm is now changed, as it is brought down and carried forcibly across the chest, which throws the head of the humerus backward and upward, making tense the capsular ligament, and shows the opening made into the joint by the passage of the knife. The point of the knife is now drawn firmly across the capsule, and as the arm is rotated forcibly inwards and then outwards, all of the muscles attached to the greater and lesser tuberosity of the humerus are, in turn, divided by this incision, which opens the joint largely, and allows the head of the humerus to slip out from its covering. The blade of the knife is then passed on the inner side of the head of the bone, completes the section of the capsular ligament where it is attached to the neck of the humerus, and grazing the bone for the distance of three inches, allows ample room for the assistant to follow the knife with the thumb of his right hand buried in the wound, and to seize the pulsating brachial artery between the thumb within the wound and the fingers of the right hand in the axillary space. As soon as the artery is firmly secured in the fingers of the assistant, the operator completes the section of the inner flap by cutting directly outward to the surface (plate 5,

fig. 4), forming a flap of similar length to the one on the outer side of the arm. The object in grazing the humerus in the descent of the knife is to avoid cutting any vessel, and especially the axillary artery, until it could be secured in the flap by an assistant. If this step of the operation is properly performed, there is no necessity in attempting to compress the subclavian artery above the clavicle, which is not only a difficult manœuvre, owing to the positions into which the arm must be placed, but cramps the operator. When the amputation is completed, the large brachial artery is carefully secured by ligature before the assistant loosens his hold upon the vessel. The circumflex vessels will also require tying. If the amputation be performed for disease, the glenoid cavity must be carefully examined, and any necrosed portion be removed by the pliers or gouge; several points of suture close the wound, the ligatures passing out at the superior portion of the wound. A small opening is allowed at the inferior portion of the flaps for drainage from the cavity of the stump.

Larrey's operation, or the oval method.—The steps of this operation are as follows: The limb being placed parallel with the trunk, the operator, grasping the arm by passing his fingers in the axilla and thumb on the outer side, so as to force outward the head of the humerus (plate 6, fig. 5), thrusts the point of a strong, stout knife into the shoulder, immediately below the acromial process, and makes a longitudinal incision of two inches in length, extending down to the bone. From the extremity of this he makes an incision on each side of the joint, passing obliquely downward and outward, forming an open V. These also pass directly to the bone, and two flaps are dissected boldly up, so as to expose the articulation. Wit hthe point of the knife carefully guided by the surgeon, so that it can not wander about in the depth of the incision to wound important vessels, the anterior portion of the capsule is largely opened, the muscles attached to the greater and lesser tuberosity divided, and the head of the humerus forced out, by using the arm as a lever, or by the fingers in the armpit. The blade of the knife is then passed behind the humerus, grazing the bone downward for nearly three inches. The assistant follows the knife in the wound to secure the humeral artery between his fingers and prevent bleeding, when the flap is cut directly outward toward the axilla, completing such a flap as is seen in plate 6, fig. 6. During this amputation the circumflex vessels are divided in the first step of the operation, and are secured by the finger of an assistant compressing in the wound. As the brachial artery is in the inferior portion of the flap, it can be readily secured by an assistant before divided. All bleeding vessels are tied, and the opposing surfaces of the flap retained in perfect apposition by a sufficient number of sutures.

The disarticulation of the shoulder can be equally effected by an anterior and posterior flap, or by a single long anterior flap formed of the deltoid muscle—Dupuytren's method.

AMPUTATIONS UPON THE INFERIOR EXTREMITY.

In amputation of a toe (plate 7, fig. 3), either by the double lateral flap or the oval method, identically similar steps are followed as for the amputation of a finger, and, therefore, the minute detail of this operation need not to be repeated. The same rule holds good for amputation of all the toes, as seen in plate 7, fig. 5. A double flap is made, with convexity downward, including all of the soft parts extending to the interdigital web, both upon the back of the foot and from the sole. It requires all of these soft parts to cover the heads of the metatarsal bones without making traction on the flaps.

The tarso-metatarsal amputation, or Lisfranc's, is an operation performed much more frequently than required. The articulation between the tarsal and metatarsal bones is an intricate one, requiring much anatomical knowledge to open with facility the line of joint, while a saw run through the metatarsal bones, an inch more or less from the joint, would simplify wonderfully this troublesome operation. In gunshot injuries to the anterior portion of the foot, in advance of the tarsal bones, where amputation is necessary, the transverse section of the tarsal bones is one always to be preferred, and should be the method regularly adopted in army surgery. When, as the result of diseased action from gunshot injuries, the heads of the metatarsal bones become involved, Lisfranc's amputation may become necessary. In all amputations through the foot, whether it be by section of bones or isolation at joints, the flap to cover the end of the stump is formed from the sole of the foot.

If we examine plate 7, fig. 1, we will see that four irregular bones, comprising the anterior row of the tarsus, are opposed to the heads of the metatarsal bones of the five toes—all of these bones being intimately bound together by ligaments. If the index finger of the operator runs over the inner face of the big toe, and continues upward upon the inner side of the foot, after passing over the shaft of the metatarsal bone of the big toe it meets with a prominence, then a slight depression, and immediately a second elevation. The first of these is the prominent head of the metatarsal bone, the second an elevation upon the inner face of the internal cuneiform, *g*, and the depression between them marks the articulation. In passing the finger over the outer side of the little toe at junction with metatarsal bone, a decided

prominence is felt a little beyond the middle of the foot, which corresponds with the projecting head of the fifth metatarsal bone, *f*. Immediately behind it is its articulating surface with the cuboid bone. Should any difficulty exist in determining the articulation of the big toe, as this head of the little toe is always very prominent, one inch in front of a line drawn from this prominence directly across the foot will correspond with the articulation of the first metatarsal and internal cuneiform.

These points having been determined, the foot to be removed is drawn down until the heel rests upon the edge of a table or resisting surface. The palm of the left hand of the operator is applied to the sole of the foot, the thumb marking the head of the metatarsal bone of the little toe, if it be the right foot to be amputated, and the index finger (plate 7, fig. 4) marking the site of the corresponding articulation of the external cuneiform with the first metatarsal. The skin upon the dorsum of the foot having been drawn backward by an assistant, a convex incision is made a little below, but terminating at the points indicated by the thumb and index fingers. Having exposed well the bones by dividing all the tendons passing over the back of the foot, the point of the knife is passed around the prominence of the head of the fifth metatarsal bone, when it at once enters the joint between this bone and the cuboid, and, following a slightly curved line downward and inward, passes between the fourth and third metatarsal on one side (plate 7, fig's 1, 5, 4, 3) and the cuboid and external cuneiform, *f i*, on the other. Its further progress is now barred by the head of the second metacarpal bone, 2, which, passing further backward than any other of the five bones, is received in a box formed between the internal and external cuneiform bones, *i g*. It is here intimately secured in place by strong interosseous ligaments, which can only be severed by adopting the course exhibited in plate 7, fig. 6. The heel of the foot being firmly kept upon the edge of the table by the assistant, the surgeon, drawing the portion of the foot to be removed firmly downward, thrusts the point of the knife very obliquely between the upper portion of the intermuscular space between the first and second metatarsal bones, until he feels that the point has passed beyond the depth of the articulation, when, by raising the handle of the knife, the end of the blade divides the interosseous ligaments, as seen in the figure. A similar procedure is effected between the heads of the second and third metatarsal bone to divide the ligaments uniting the head of the second metatarsal bones with the middle and external cuneiform. If the anterior portion of the foot be now drawn forcibly downward, and the point of the knife be drawn over the back of the foot across the supposed seat of the articulation, between the second metatarsal and middle cuneiform, 2, *f*, it will open, and also cause

the ligaments binding the head of the first metatarsal to the internal cuneiform to yield, when the section of all the anterior ligaments will be completed, and the joints widely opened, as in plate 7, fig. 7. As soon as the blade passes into the sole beyond the articulating faces of the bones the blade is placed horizontally, the toes elevated, and a flap is cut parallel with and grazing the inferior face of the metatarsal bones. When the knife has traversed nearly the entire length of the sole of the foot, the toes are again depressed, the portion of the foot to be removed held perpendicularly to the flap, and the knife, also held perpendicularly, carves out a regular termination for the flap, and separates it from the foot, as in plate 7, fig. 8. It requires the entire length of the sole of the foot to form a flap sufficiently long to cover readily, without traction, the exposed surfaces of the tarsus—plate 8, fig. 1, *a a a*. The sesamoid bones, at the ball of the big toe, will interfere with the formation of the flap if their presence is not recognized and the knife made to glide over them. Ligation of the plantar and dorsal arteries, and closing the wound by attaching the flap to the anterior incision upon the dorsum by means of a sufficient number of sutures, completes the amputation.

Chopart's amputation, or the medio-tarsal, between the scaphoid and cuboid in front (plate 7, fig. 1, *e f*) and the astragalus and os calcis behind, *c d*, is performed in a similar manner to Lisfranc's, the flap being taken altogether from the sole—plate 8, fig. 1, *b b b*. The medio-tarsal joint is found by the following landmarks: In examining plate 7, fig. 1, the outer surface of the scaphoid bone forms quite a prominence, which can readily be felt by running the index finger upward upon the inner face of the foot. The first projection felt is the head of the metatarsal bone of the big toe, 1; then the prominence of the internal cuneiform, *g*; and the third knob felt as the finger passes toward the heel on a line with the extremity of the inner malleolus, is upon the scaphoid bone, *e*. Immediately behind this third knob is the articulation between the scaphoid and astragalus. Should the foot be examined from behind, three-quarters of an inch in front of the inner malleolus will be found the prominence upon the scaphoid bone, *behind which* is the articulation. On the outside of the foot the articulation of the cuboid with the anterior face of the os calcis is found with equal facility. The prominent head of the metatarsal bone of the little toe can always be felt; one inch behind this is the articulating surface; or immediately in front of the external malleolus is a tubercle upon the outer face of the os calcis, and *in front* of this is the joint.

In operating upon the left foot, it is seized in the left palm of the surgeon, with the prominent landmarks for the joint marked by the

thumb upon the tubercle of the scaphoid and index finger of the left hand, one inch behind the tarsal end of the metatarsal bone, as in plate 7, fig. 4. The surgeon makes a slightly convex incision across the back of the foot from one landmark to the other, or one and a half inches in front of the malleoli. This incision dividing all of the soft parts to the bones, the heel being fixed upon the table, the surgeon draws the foot forcibly downward, which puts the anterior ligaments upon the stretch, allows the knife to divide them, and enter readily between the articulating surfaces—plate 7, fig. 9. Care must be taken to keep the knife behind the tubercle upon the scaphoid; if it passes in front of this, the joint between the scaphoid and cuneiform bones is opened, and the scaphoid bone is left on the wrong side of the stump. When the knife has passed through the joint the blade is placed horizontal, as in the second part of Lisfranc's amputation; and while grazing the bones, a flap is formed of the sole, and completed, as in fig. 8. Fig. 10 shows the appearance of the stump after section of the plantar flap, also the position of the dorsal and plantar vessels which will require ligatures. Sutures in sufficient number attach the flap to the anterior wound, and are especially required in foot amputations.

Syme's amputation of the foot, or the tibio-tarsal disarticulation. It is sometimes found that a ball in its passage has so crushed the tarsal bones, including the anterior portions of the astragalus and os calcis, that the removal of the whole foot is required. In examining plate 7, fig. 1, we find that the styloid processes of the tibia, *a*, and fibula, *b*, project downward below the level of the articulating face of the tibia, forming a box or groove in which the rounded head of the astragalus, *c*, plays, making a hinge-joint of this articulation. Powerful internal and external lateral ligaments bind the malleolus to the astragalus and os calcis. The anterior and posterior ligaments partake of the capsular variety, but do not give strength to the joint. To amputate by the method of Syme, after administering chloroform the circulation through the limb is secured either by compressing the femoral artery in the groin, or by an assistant placing one thumb over the anterior tibial artery as it runs over the ankle, midway between the malleoli (plate 17, fig. 3, *a*), and the fingers of the other hand over the course of the posterior tibial artery (plate 18, fig. 2), as it runs on the inner side of the leg and midway between the inner edge of the tibia and the tendo achillis. Two incisions are then made in the direction of the lines, *c c c*, plate 8, fig. 1. The ends of the malleoli being clearly ascertained, an incision through the skin and tendons is made on the instep, extending from one malleolus to the other. The direction of the knife is then changed: the heel of the blade is placed at the termination of the dorsal incision under the tip of the external malleolus, and passing obliquely

backward under the sole, is continued obliquely upward and forward, fig. 1, *c c c*, to meet the termination of the dorsal incision under the inner malleolus. The foot being forced downward, using the heel upon the end of the table as a fulcrum, the tibial joint is largely opened upon the anterior face, the lateral ligaments next divided with the point of the knife, which allows the head of the astragalus to glide forward (plate 8, fig. 2), leaving the articulating face of the tibia fully exposed. The foot is still further depressed, the posterior ligament divided, and the attachment of the tendo achillis very carefully separated from the foot by cutting it away from the posterior surface of the os calcis. The dissection of the sole in the line of flap is completed by thrusting the thumb into the inferior incision, and applying the point of the knife between the thumb-nail and the inferior and lateral surfaces of the os calcis. When the foot is removed it will be found that, however closely the posterior surface of the os calcis is grazed, the skin in the flap corresponding to this portion is always very thin. If the dissection be attempted without care, the flap will be perforated during this step of the amputation. When the foot is removed, the malleoli are sawed off smoothly on a level with the articulating face of the tibia; the dorsal and plantar arteries, two in number, secured, and the flap brought forward and retained by sutures. The objection to this operation is that the flap forms a cup from that portion of the heel which covered the calcis, and as such can not be brought in perfect apposition with the opposing surface, but remains separated, a receptacle for blood, pus, etc. The leg is shortened two inches by this amputation.

A modification of the tibio-tarsal disarticulation, introduced to the profession by a Russian surgeon, Pirogoff, is a decided improvement upon the plan adopted by Syme. The anterior incision extends from one malleolus to the other, and is joined by an incision extending obliquely backward and downward under the sole. The joint is largely opened from the anterior surface by the division of the anterior and lateral ligaments. To this point of the operation it has differed in no respect from that of Syme, except that the plantar incision runs more obliquely backward: from this point the differences of the operations become apparent. After the astragalus has been freed from the tibia, instead of dissecting the tendo achillis from the heel, the saw is placed directly behind the head of the astragalus, and the os calcis is divided in the oblique line of the plantar incision. The malleoli and articulating face of the tibia are then sawed off obliquely, so that when the flap is brought upward the oblique face of the calcis will be brought in nice apposition with the obliquely-cut face of the tibia, and retained in immediate juxtaposition by sutures. When these bones become united, which they soon do, a good solid stump is formed, which readily bears the weight of the body, and

the leg is found very little shortened when compared with the sound limb. The very great advantages of this modification is the more rapid performance of the operation, obviating the tedious dissection of the plantar flap, and isolation of the os calcis, with division of the tendo achillis. It also leaves no cupped flap for the collection of secretions, and, moreover, the portion of the os calcis retained adds from one to two inches to the limb. Plate 8, fig. 3, shows the appearance of the wound after amputation with solid inferior flap, and fig. 4 indicates the appearance of the stump after cicatrization in Pirogoff's amputation. In the after-treatment of this amputation it must not be forgotten that until the skin has firmly cicatrized, and the bones have, in a measure, become united, the leg should be kept somewhat flexed upon the thigh; otherwise the constant contraction of the tendo achillis would displace the remaining portion of the os calcis from its apposition with the tibia, and prevent immediate consolidation. After all amputations of the foot, should the stump, when cicatrization is complete, be found too much drawn backward, and its usefulness thereby interfered with, a subcutaneous section of the tendo achillis will be required to correct the position of the tarsal bones.

AMPUTATIONS OF THE LEG.

In these days of mechanical ingenuity and perfect artificial limbs, it is matter of moment to leave as long a stump as possible for the better support of an artificial leg. Formerly the seat of election for amputating the leg was four fingers' breadth below the inferior border of the patella. Now we operate at any available point of the limb The circular operation is the one usually preferred upon the leg. In amputating immediately above the ankle some difficulty is found in turning up the cuff of skin over the larger circumference of the conical leg. To facilitate the dissection of the flap, a perpendicular incision, two inches long, is made upon the anterior surface of the tibia, commencing over the point where it is intended to divide the bone. At the lower extremity of this incision a circular cut is made round the leg, and the skin rapidly dissected from the muscles by lifting the two anterior flaps as high as the perpendicular incision will allow. These flaps are well drawn back, and the knife, held obliquely from above downward and backward, cuts up a flap of muscles from the back of the leg. This posterior flap is dissected upward until it reaches the level of the commencement of the perpendicular incision, when the remaining and interosseous muscular fibres are divided by passing the knife first circularly around the bones at the base of the flap, and then between the two bones, cutting with a sawing motion, first upon the tibia, then upon the

fibula. To complete the figure of 8 movement between and around the bones, so as to divide all of the muscles, the knife must be first thrust between the bones from above downward, then from below upward. A broad, three-tailed retractor is placed between and around the bones for the protection of the flaps, while the bones are divided by the saw. Plate 8, fig. 5, shows the appearance of the open stump after the removal of the leg through its lower third, by the method of Lenoir, above described; *a*, *b*, the two-pointed flaps dissected upward. *f*, the anterior tibial vessels lying upon the anterior surface of the interosseous membrane; *d*, the posterior tibial, and, *e*, the peroneal arteries, will all require ligation. In closing the flap apply points of suture, first to the perpendicular incision, and then close the circular portion of the wound.

Amputation, four fingers' breadth below the patella, is the common site chosen for amputating the leg—having this great advantage among the poor laboring classes who can not procure an expensive artificial limb: that when the wooden pin is worn (plate 24, fig. 6), a long stump does not protrude behind, much to the inconvenience of the wearer. The best results are obtained from the circular amputation. Chloroform is administered, and the lower portion of the body of the patient stripped, so that an assistant can secure the circulation through the limb by compressing the femoral artery at the groin, under the middle of Poupart's ligament, where its pulsation can be readily felt, as the vessel courses over the ridge forming the acetabulum—plate 14, fig. 6. Should there not be sufficient help present, the pad of a screw tourniquet is applied over the course and pulsation of the femoral artery, and tightened sufficiently to stop pulsation in the vessel below the tourniquet. The surgeon, in the meantime, sees that all the instruments which he may have need for during the operation are at hand, viz: an amputating knife, sufficiently narrow toward the point of the blade to pass between the tibia and fibula; a stout scalpel, for facilitating the dissection of the circular flap of skin (in the hands of a careful surgeon, the skin can be as well dissected up by the amputating knife—in the hands of one not familiar with the use of a long knife, the hands of the assistant will be in serious danger, hence the scalpel is recommended for this step of the operation); a saw, tenaculum, artery forceps, and bone-pliers, which, with a three-tailed retractor, ligatures, and a surgeon's needle, completes the necessary instruments. Two assistants are needed: one to compress the artery in the groin; the other to elevate and retract the flaps, and support the upper portion of the leg.

The point of section of the bones having been determined, the surgeon kneeling, with right hand holding the knife passed under the limb to be removed, places the heel of the knife on the anterior surface of the leg, reaches three inches below the point where the bones are to be

divided, the point of the knife toward his shoulder, and, by a sawing motion, watching the heel of the knife and raising himself as he cuts, makes a circular incision around the limb. As it bends the wrist to a straining posture to complete the circle by one sweep of the knife, it is better, after completing three-quarters of the section, to change the position of the knife, and placing the heel of the blade at the point where the incision was commenced, cut in a sawing motion across the anterior surface of the leg to join the first incision where left off. The skin is now drawn up by the fingers of the left hand, or by a forceps, when, with a few bold strokes of a sharp scalpel, it is isolated from its cellular connections with the muscles, so that the surgeon can turn it up, cuff-like. Once rolled over, it is only necessary to apply the edge of the scalpel to the cellular tissue at the fold of the everted skin, as the assistant draws it upwards, when it can be rapidly dissected to the required height. The long knife now being resumed, the operator places himself, with bended knee, in the first position (plate 8, fig. 6), and commencing a second incision on a level with the cuff-like flap, cuts boldly through the muscles to the bone in passing around the entire limb, as before. The soft parts being drawn backward by the fingers of an assistant thrust into the wound, the surgeon, watching lest he wound the fingers of the assistant, passes the narrow portion of the blade, which is usually double-edged, through the interosseous space from below upward, cutting with a sawing motion on each bone in turn. When all of the muscular fibres on the inferior portion of the limb have been divided, the knife is withdrawn, to be thrust between the bones from above, to complete the section of the muscles which had, up to this time, escaped. When the bones are completely bared, a three-tailed retractor (plate 8, fig. 7, *a a*) is applied to the stump, the centre tail passed between the bones, the outer strips folded on the outer and inner side of the stump, and the whole retracted so that the soft parts will be protected from the saw.

In commencing the division of the bones, fix the heel of the saw upon the anterior surface of the tibia, by enclosing it between the stump and the left thumb-nail of the operator, and saw very obliquely for a few strokes, cutting the crest of the tibia obliquely for three-quarters of an inch; the heel of the saw is then placed at right angles to the bone, one-quarter of an inch below the first section, and, fixed in position by the thumb-nail, commences to groove anew the tibia. After entering the substance of the tibia, the saw is so elevated or depressed, depending upon the limb operated upon, as to complete the division of the fibula first, and then finishing the section of the tibia. The object of making first an oblique section of the spine of the tibia was to remove this sharp prominence of bone, and prevent pressure and ulceration through the flap. An examination of plate 8, fig. 8, will show the position and num-

ber of the vessels requiring ligation, viz: anterior and posterior tibial, peroneal, and sural arteries. At times the section of the bones is made so near the head of the tibia, or the popliteal runs so low down before it bifurcates, that but one artery requires ligation—the inferior portion of the popliteal, above the origin of tibial and sural vessels. One end of each ligature is cut off, and the remaining thread secured upon the outside of the leg by a piece of adhesive plaster, and the lips of the skin flap kept in apposition by means of a sufficient number of sutures. A cold wet cloth, frequently renewed, is all the dressing required.

The flap amputation, when preferred, is performed as follows: The point where the bones are to be sawed having been determined, and similar arrangements having been made as in the circular amputation for controlling the circulation through the femoral artery, a convex incision is made upon the anterior surface, extending from the outer border of the fibula to the inner border of the tibia, about half an inch below the point of section in the bone. As the tibia lies very superficially upon the anterior portion of the leg, the incision is only skin-deep—plate 9, fig. 2, *g k k*. As soon as this small anterior flap is traced, the surgeon, standing on the inner side of the leg, if he is operating upon the right limb, thrusts a long, sharp, narrow knife into the calf, directly under the inner border of the tibia, at the termination of the anterior incision, and passing horizontally through the limb, taking care to keep the knife immediately behind both bones, makes the point protrude at the commencement of the anterior incision on a level with the posterior face of the fibula—plate 9, fig. 1. Fig. 4, *d t g*, defines the position of the two incisions. The surgeon cuts down, parallel with the two bones, for a distance of three inches, when the edge of the blade is turned obliquely backward, and cuts out the long posterior flap. The anterior flap is separated from its deeper parts for half an inch, and the knife is then thrust between the bones both from above downward and from below upward, cutting alternately upon each bone, and then making a circular incision around the bones, in order to divide the interosseous ligament and all remaining muscular fibres not included in the flaps. The two flaps are then well drawn back by an assistant, who uses either his hands clasping the stump, or a three-tailed retractor, and the surgeon applying the heel of the saw held obliquely to the bone, and fixing it between his thumb-nail and the anterior flap, cuts to the depth of half an inch. He then places the heel of the saw one-third of an inch lower down, at right angles to the bone, and with rapid to and fro motions, without bearing too heavily upon the saw, divides partially the tibia, and completes the section of the smaller bone, the fibula, before the tibia is completely divided. Four arteries usually re-

quire ligation: the anterior tibial, between the tibia and fibula, upon the anterior surface of the interosseous membrane, and three vessels in the posterior flap, viz: the posterior tibial, peroneal, and sural vessels. When the heavy, voluminous posterior flap is brought over the surface of the bone to be covered, it is always found so thick that it has to be puckered and even stuffed into the cavity of the stump, to make the rounded margin adapt itself to the small cutaneous anterior flap. The irregular adaptation is often the cause of a failure in obtaining quick union, and the stump heals usually by the slow process of granulation and suppuration. As the size of the posterior flap is the only serious objection to this otherwise good operation, it can be readily overcome by laying the flap upon the palm of the left hand before the arteries are tied, which will make the mass of muscles rise in a ridge in the centre of the flap, when, with a sharp knife, a heavy steak is taken from the face of the flap, which reduces it to a thin layer of muscular tissue and skin. In this condition all objections to the posterior flap from size and weight are removed, as it will now adapt itself perfectly to the anterior flap, and make, in every respect, a creditable stump. Sutures and a wet cloth complete the dressing.

In using an artificial limb, after an amputation of the leg, the pressure of the false limb is not allowed upon the cicatrix, but is borne chiefly by the lower border of the patella and condyles of the femur, the support being extended upon the thigh, and in some instances even to the trunk. In the use of the common wooden pin, as seen in plate 24, fig. 6, the stump is bent at right angles to the thigh, and the entire pressure is applied to the knee—the stump, untrammelled, jetting behind the apparatus.

In *amputating at the knee-joint*, one of two methods may be adopted. In one, the knife is drawn directly across the knee below the patella (plate 9, fig. 4), the incision at once passes through skin, ligamentum, patellæ, and capsule, entering boldly into the knee-joint, and, severing the strong internal and external lateral ligaments, traverses the entire articular surface. As soon as the head of the tibia can be luxated forward, the blade is placed behind this bone, and grazing its posterior surface in its descent, cuts a posterior flap—plate 9, fig. 4, *a b c*. While the perpendicular portion of the posterior flap is being made, which should be about three inches long, the assistant might thrust his hand into the wound and secure the popliteal artery. After ligation of all bleeding vessels, most of which will be found in the posterior flap, the soft coverings for the head of the femur will be retained in position by a sufficient number of sutures.

As this posterior flap operation has the same objection which was urged to the posterior flap in amputations in the upper third of the leg, surgeons have reversed the position of the flap, taking it solely from

the skin upon the anterior surface of the leg—plate 9, fig. 5. The landmarks about the knee-joint having been determined, an incision is commenced upon the outer face of the tibia, just below the centre of the external condyle of the femur. After descending vertically for three inches, the knife sweeps in a convex incision across the anterior surface of the leg, and is continued upward on the inner side of the leg, in a similar perpendicular incision of equal length, terminating below the centre of the inner condyle—plate 9, fig. 5, *a b c*. This flap of skin is dissected up from the face of the tibia, *t*, and everted, cuff-like, is drawn over the lower anterior extremity of the femur, until the base of the fold exposes the anterior ligament of the knee-joint, when the knife cuts directly into and through it, completing the removal of the leg by making a circular incision directly backward in the line of the joint.

This is the better operation of the two flap disarticulations, as the cicatricial line is placed behind the limb, where it will be comparatively protected. When the cicatricial line lies on the anterior face of the stump, it is liable to frequent and painful injury.

AMPUTATION OF THIGH.

In the thigh, as in the amputation of every portion of either limb, the surgeon has the choice of either circular or flap methods—the flaps being made in an antero-posterior, lateral, or oblique direction, as the case may require or the fancy of the surgeon suggest. As has been before stated, the circular method is now generally preferred by most operators, especially those who have not had much experience in the removal of limbs, inasmuch as the circular flap of skin is much more likely to be ample than where flaps are cut, which, in the hands of the inexperienced, are always made too short. In examining the reported lists from the Surgeon-General's office it is found that of 917 capital amputations where the method adopted was reported, 562 were by the circular method, and 355 were flap amputations. Of 233 amputations of the thigh, 131 were by the circular method. These figures show clearly the preference given to the circular over the flap operation.

Flap amputation.—Where the surgeon shows a preference for the flap method, he stands in such a way that he can seize the muscles upon the anterior portion of the thigh with his left hand, and while a careful assistant compresses the femoral artery in the groin where it courses over the pubic bone, a long, narrow, sharp-pointed knife is plunged into the lateral surface of the leg, and continues its onward progress until it

strikes the centre of the lateral surface of the femur. Depressing the handle, he continues the onward movement of the knife until it glides over the anterior face of the bone, when he elevates slightly the handle, and pushing the knife directly forward across the limb, the point appears through the skin on the opposite side of the thigh, when the knife will have fully one-half the thickness of the limb upon the blade. Grazing the femur, the operator cuts directly downward until he has sufficient length of flap, when he turns the edge of the blade outward and completes the flap. The flap being now held up by an assistant, the point of the knife is again entered a little lower down than before, through the cut muscular surface, and passing under the femur, appears again through the cut muscular surface on the opposite side of the limb—plate 10, fig. 1. The object of passing the knife through the muscles is to avoid cutting the skin irregularly at the point of transfixion. The posterior surface of the femur is grazed, as was its anterior in the first step of the amputation, and when a sufficient length of flap has been formed, cuts directly outward. The two flaps are drawn back by an assistant, the surgeon sweeps the knife around the bone at the base of the flaps to divide all muscular fibres not severed in the cutting of the flaps, and then applies the saw to the femur as high up as possible, fixes the heel of the blade between the nail of his left thumb and the base of the flap, and drawing it steadily toward him, readily grooves a passage for it upon the bone. Should the limb not be steadily held during the sawing, any sharp spicula of bone left by the snapping of the femur must be removed by the bone forceps.

In locating the flaps, the knife should be so directed that the femoral artery escapes the first section, and is found at the base of the second or posterior flap—plate 10, fig. 2. The length of the flaps must depend upon the size of the limb. A good rule is to make them ample, even larger than may be required: retraction and contraction of the flap will soon remove all excess, when a too closely fitting flap, by its shortening, may be so drawn over the end of the bone as eventually to cause its exposure and protrusion. One-fourth the circumference of the limb would make a sufficiently ample flap—if the thigh be twenty inches in circumference, the flaps should be five inches long. When nicely cut and properly attached by sutures, they adjust themselves as perfectly as the two valved shells of an oyster.

In the circular amputation many methods may also be adopted. The circular flap of skin may either be dissected up, cuff-like, for four or five inches, when all of the remaining soft parts are severed perpendicularly to the bone; or the following course may be adopted: Having chloroformed the patient and secured the circulation through the femoral artery, either by pressure at the groin or by means of a tour-

niquet, a circular incision is made around the thigh from four to five inches below the point at which it is designed to saw the bone. To effect this circular incision the surgeon kneels, and passing his arm under the limb to be amputated, bends the wrist so as to place the heel of the blade on the anterior face of the limb, the point of the knife nearly touching the right shoulder of the surgeon. With a sawing motion he commences the incision, and, watching the heel of the knife as he rises, may, by flexing forcibly the wrist, complete the circuit of the member. This position being a forced one, however, it is preferable, after cutting three-fourths of the circumference of the limb, to change the position of the knife. Place the blade over the member with the point looking away from the operator, and commencing the second incision in the line traced at first by the knife, complete the circle by ending where the first incision left off. The skin being equally retracted by an apt assistant, will cause the gaping of the wound for nearly an inch. The knife, placed again in the same position as at first, follows the upper line of the retracted skin, cutting through all of the muscles. This enables the assistant to retract the soft parts, leaving from two and a half to three inches of gaping. A third incision, following as before the upper contour of the cutaneous incision, divides for a third time the muscles, permits of ample retraction of the soft parts to make a large conical flap, and at the same time isolates the shaft of the femur, preparing it for the saw—plate 10, fig. 3. A retractor, in this figure, composed of a slit piece of cloth, protects the soft parts from being injured by the saw. The flap, before it is closed, represents an inverted cone, the cut surface of the bone forming the truncated apex, while the retracted muscles form the sides of the cone (plate 10, fig. 4), having the skin as a base. This is one of the best methods of amputating, giving excellent results, as the circular flap, the edges of which are composed solely of skin, shows a strong disposition to heal by quick union. The bone is so well covered that a conical stump rarely results from this operation, while at the same time there is no excess of muscle in the flap to induce suppurative inflammation.

Amputation at the hip-joint is an operation so serious in its results—nearly every case being fatal—that it is a question whether its performance should not be confined to the amphitheatre. Military surgeons have at times thought the operation called for, and have performed it with invariably the same fatal result; so that the question is often forced upon them whether it would not be preferable to leave the patient to his fate, which, under no condition, can be more serious than the operation. There is an unfortunate ambition—we might even use a stronger term for it—a criminal desire to have an amputation at the hip joint in the list of operations performed, which misleads many sur

geons to perform this disarticulation, when their better judgment teaches them that it must be a useless mutilation. Most that can be said in its favor is that it relieves the wounded of a lingering death, as it hastens this issue. As one case of primary amputation at the hip-joint during this war has recovered, and as a limb may be so torn off or extensively mutilated that the operation may be justifiable—even as a very temporary measure—to relieve the wounded man of a mangled limb, the method of performing the disarticulation will be given.

Plate 10, fig. 5, indicates the relative position of the pelvic bones with the femur, and shows where the head of the thigh-bone hides itself in the deep acetabulum. Amputating by the double flap is found the most convenient method. To form the anterior flap, if the amputation be performed upon the left thigh, the limb being slightly flexed and abducted, a long, sharp, narrow knife is entered from the outer side of the thigh immediately above the upper and outer border of the great trochanter, and is carried directly inward until it strikes the neck of the femur. The handle of the knife is then slightly depressed to allow the point to glide over the junction of the head with the neck, cutting through the capsule. The direction of the knife must now be changed, otherwise the point would pass into the abdominal cavity. The handle should be carried upward and forward, which depresses the point and allows it to make its appearance on the inner side of the thigh, one inch in front of and below the ischial tuberosity—plate 10, fig. 5. The heel of the knife cuts downward in the direction of *c b*, grazing the bone, and is followed by the hand of an assistant thrust into the wound and securing the femoral artery. The flap is completed by cutting out in the direction *a b*. This flap is then drawn upward upon the abdomen by the assistant, who secures the vessels by pressure; the thigh is carried downward, backward, and outward, which causes the head of the femur to stretch the anterior portion of the capsule; an incision directly across this releases the head, which, as the ligamentum teres, the round ligament attaching the head of the femur to the cotyloid cavity, is severed, escapes from the acetabulum, with a sucking noise.

The amputation is completed either by passing the knife behind the neck of the femur and cutting a flap obliquely downward and backward, corresponding to the line of anterior incision, or this flap can be made by cutting from without inwards, as follows: the operator, kneeling, passes the heel of the amputating knife on the inner side of the thigh, and, commencing an incision from the inner angle of the anterior flap, cuts obliquely downward and outward until a flap of sufficient length is made, when he brings the heel of the knife, with a sawing motion, across the limb, then upward and outward to terminate the incision at the point of transfixion. The capsular ligament and

remaining muscles in the vicinity of the joint, attaching the thigh to the trunk, are divided from above backward. The large arteries requiring ligation are the femoral and its profunda branch, which are on the inner side of the anterior flap, accompanied by their veins, *f f* (plate 10, fig. 7). The bleeding vessels in the posterior flap are comparatively small muscular branches. As the patient, during this operation, often dies from the loss of blood, it has been recommended to ligate all bleeding vessels in the anterior flap before the section of the posterior flap is commenced. The closure of the wound by sutures, and the subsequent cold water dressing, is common to all amputations.

RESECTIONS.

Resections of the heads of bones are offered as a substitute for amputations. Experience in military surgery has shown that when a ball passes through a large joint, crushing the heads of the bones, it produces a very serious lesion, which, without an operation, would be classed among the mortal wounds. Attempts at treatment, without the use of the knife, would in most cases terminate fatally; and even where the life was saved, the limb would be a stiff and useless one. So aware were surgeons of the little success following the treatment of such joint injuries, that they had established the rule, of amputating in all such wounds. Conservative surgery has introduced resections as a very decided improvement over amputations, inasmuch as it not only saves the limb, thus protecting the patient from the fatality of amputation, but leaves him with a very useful extremity.

Although the resection of each joint has its peculiarities, there are certain rules in the performance of the operation common to all resections. One of these is, that the joint should always be opened in such a way as to avoid all of the large vessels and nerves. As these vessels always run over one face of the articulation, the incisions necessary to expose the heads of the bones should always be made upon the opposite surface. Straight incisions are usually preferable to flaps, as the muscles are not cut up, and therefore their action not paralyzed, as is usually the case in flap operations. The perpendicular incision should always be made ample, to expose perfectly the heads of the bones, and give room for manipulation; a free incision expedites the resection, facilitating every step of the operation. When this incision is too short the movements of the operator are very much cramped, especially as regards the ligation of divided vessels, the isolation of the bones, and the eversion of their extremities. This straight incision should pass

directly to the bone by a single stroke of the knife, and the head of the bones isolated by dissecting up from the bone all the muscles and periosteum also with it, if possible. By keeping the point of the knife grazing the bone, the main blood-vessels and nerves running through the soft parts are not disturbed. All tendons running over the joint to supply distant parts must be carefully drawn aside, and not divided. Usually it is found most convenient to turn the head of the bone out of its socket before the saw is used. To effect this, all of the muscles and ligaments which are attached around the neck of the bone must be divided, which can only be safely accomplished by rotating forcibly the shaft inwards, then outwards, which will bring the various muscles into the straight incision and under the point of the knife. In isolating the head of the bone, and releasing it from its cavity, the point of the knife should never get out of sight, as important parts may very easily be injured by the point buried in the wound. When the head of the bone has all of its connections severed, and is thrust out of the wound, we should place behind it a guard, composed of a strip of wood, the handle of a knife, or the blade of a spatula, to protect the soft parts while the saw is dividing the neck of the bone.

In gunshot wounds, as the head is often crushed from the shaft, the portion remaining in the articulating cavity must be seized with a strong tooth forceps, so as to obtain a leverage upon it, and by rotating the extremity the capsule and muscles can be divided, and the head withdrawn. The section of the shaft should always be horizontal, so as to offer a smooth, broad surface to the articulating surface above. Where the head of a bone has been fractured, the extremity of the shaft must be cut so as to leave a smooth surface. All small vessels divided during the operation must be ligated, and the wound closed by sutures, the limb placed in an easy position, and cold water dressings applied.

Union by the first intention is not expected for the entire wound. A portion of it will heal rapidly, leaving an opening for the escape of the secretions from within the cavity. During the treatment the inner surface of the wound will usually suppurate profusely, and small particles of bone may become detached from the sawed extremities. Finally, ligamentous bands unite the opposing surfaces of the bones; and while all of the movements of that portion of the extremity beyond the part resected are preserved, the new joint regains in time many useful movements.

Resection of the lower jaw is commenced by drawing out the incisor, or canine tooth, corresponding to that portion of the jaw to which the saw is to be applied. With a sharp-pointed bistoury an incision is made along the base of the jaw, extending from its angle to

the point of section of the bone, which is usually within a half-inch of the symphysis menti, or median line of the chin. This incision extends to the bone, and as it divides the facial artery, in its course over the face, in front of the masseter muscle, this vessel should be at once tied. The next step of the operation consists in isolating the gums and floor of the mouth from the maxillary bone at the point where the section is to be made. When the finger, from the outer wound, can be passed readily into the mouth, both above and below the bone, the lower jaw is to be divided, either by passing a chain-saw around the bone and with steady traction sawing it through, or by using a strong Liston forceps, which requires more strength in the hand than surgeons usually possess; or by placing a spatula under the bone for the protection of the soft parts, and using a small saw. As soon as the section is completed, the portion of the lower jaw to be removed is drawn forcibly outward, dividing the muscular floor of the mouth attached to the mylo-hyoidean ridge. The pteregoid muscles attached to the inner face of the ramus are divided; next in order the tendon of the temporal and masseter muscles attached to the outer face of the ramus and coranoid process. Using still more force upon the lever, the head of the lower jaw is wrenched from its glenoid cavity (plate 11, fig. 1), leaving a few ligamentous bands to be divided. This is much better than burying the point of the bistoury in the depth of the wound for the purpose of dividing the internal ligaments of the joint, when it will be nearly impossible to avoid injuring the internal maxillary artery, and cause annoying hemorrhage. Should this artery, which runs in very close proximity with the neck of the jaw-bone, be cut, it must be secured by ligature. When this vessel is avoided the facial artery is the only one severed. Should there be much oozing from the depth of the wound in the vicinity of the glenoid cavity, the surface should be painted with the liquid persulphate of iron. When the flap resumes its position, and is kept in place by a sufficient number of sutures, healing rapidly takes place, and very little deformity ensues. If the operation be performed upon a man, his beard will conceal all traces of the operation.

Although the lateral portion of the inferior maxillary is most liable to disease, the anterior portion, or arch at the symphysis menti, may become carious and require removal. The bone is readily exposed by an incision upon the median line of the chin and throat, extending from the lip, which is divided, to the hyoid bone. Two flaps are dissected up, laying bare the portion of bone to be removed—plate 11, fig. 2. One tooth is drawn from each side of the mouth corresponding to the points of section, and the bone severed either by the use of the saw or Liston's heavy bone forceps. In the removal of the anterior portion of the lower jaw, as the muscles which protrude the tongue are

divided from their points of attachment on the inner face of the symphysis menti, the retractor muscles, having no antagonistic action, tend to draw the tongue backward, where, recoiling upon the larynx, and pushing down the epiglottis upon the laryngeal opening, it threatens suffocation. To obviate this the tongue is seized by a tenaculum and drawn forward. When the flaps are closed by suture the threads are passed through the phrenum of the tongue, which causes it to adhere to the cicatricial line, and the tendency to excessive retraction is corrected.

IN THE RESECTION OF THE UPPER JAW, a somewhat similar procedure is adopted. The relations of the superior maxillary bone are as follows: Upon the median line it meets the opposite superior jaw-bone, forming with it the roof of the mouth; its ascending process is attached to the os frontis, os unguis, and ethmoid; externally it meets with the malar bone, posteriorly with the palate bone and pteregoid plates of the sphenoid. To isolate the bone it must be separated from all of these.

A simple plan of operation consists in making a curved incision (plate 11, fig. 4) extending through the entire thickness of the cheek from the zygoma to the angle of the mouth. By dissecting up this upper flap from the face of the upper jaw, the entire extent of the bone can be readily exposed—plate 11, fig. 3. Having separated the nasal cartilage from the crescentic border of the nasal process, so as to open the nasal cavity through the wound, one of the incisive teeth is drawn out, and a heavy Liston forceps is applied to the jaw to sever the hard palate or roof of the mouth. One blade is placed, as in fig. 3, into the mouth in the space vacated by the extracted tooth; the other passes under the everted flap into the nostrils, and the anterior and lateral connection of the bone is readily cut through. The forceps is next applied so as to divide the nasal process with the attachment to the os unguis and ethmoid. To effect this the flap is dissected upward so as to expose the orbital cavity. One blade of the forceps is placed in the upper part of the nostril, the other into the inferior portion of the orbital cavity, and with one stroke the superior connections of the jaw are severed. Again, one blade of the forceps is placed in the outer and inferior portion of the orbit, the other in the temporal fossa behind the malar bone, when the malar connections are destroyed. Should the malar bone be also diseased, it should be removed by passing the blade of the forceps first into the outer portion of the orbit and the temporal fossa above the malar bone, and afterward severing the zygomatic arch.

The isolation of the bone is completed by putting a chisel upon the floor of the orbit, and driving it with a mallet, force it downward and backward, cutting through at the first blow the floor of the orbit and the superior maxillary nerve coursing upon it. The chisel is forced,

without much difficulty, through the posterior portion of antrum until it reaches the posterior wall of the maxilla, and finds an obstacle in the pteregoid plates. Using these plates as a fulcrum or base, the chisel as a lever, it is only necessary to depress the handle, when the maxillary bone will at once yield and be luxated from its position. The soft palate alone keeps it attached to the skull, and this can be severed either by using a curved scissors, or by thrusting a sharp-pointed bistoury into the mouth, cutting first in the median line of the roof of the mouth, and then making a transverse incision extending half-way across the posterior superior wall of the buccal cavity, two lines in advance of the pendulous portion of the soft palate. The bone is then grasped in a strong forceps, and, being turned upon its axis, exposes any remaining soft parts for division.

There is but little hemorrhage from such an operation. The superior maxillary bone, although freely supplied by many small vessels, has no large artery running upon it: and, moreover, by the use of the chisel and bone forceps the vessels have their coats so crushed that they partake of the character of contused and lacerated vessels, which do not bleed. Any oozing of blood soon ceases upon exposure of the cavity to air. The application of the liquid persulphate of iron will at once dry the surface. Although the cavity looks frightful immediately after the operation, the closure of the flap leaves but little deformity—plate 11, fig. 4. From the vascularity of the soft parts quick union is, without difficulty, obtained under cold water dressings. The sutures are removed by the fifth day, and the patient is nearly well by the end of the first week. It is a practice with some surgeons to stuff the cavity, immediately after the operation, with a piece of sponge or lint. No such stuffing is required; on the contrary, any foreign bodies in the wound are detrimental. Pus is secreted from the cavity, and is spit up some time after the outer wound has completely cicatrized.

RESECTIONS UPON THE UPPER EXTREMITY.

The clavicle may require resection, in whole or in part, from diseased action in the bone, brought on as a sequela of gunshot injury. Necrosis or caries may supervene, accompanied by pain and a constant and annoying discharge of pus from fistulous orifices at the root of the neck or on the upper portion of the chest. The chief danger of the resection of this bone, particularly its inner half, which most frequently requires operation, is in the near proximity of very large vessels, which, if injured, would destroy the patient. Fortunately for the operator,

nature, in attempting to get rid of the old diseased bone, has usually caused so heavy a deposit around the clavicle as to separate these important vessels to a certain distance, where they can be more readily avoided. A new deposit of bone has usually taken place around the necrosis, and it is only necessary to cut into this involucrum or sheath of new bone, to enable one to remove readily the diseased portion.

At times, however, it is necessary to remove the entire thickness of the bone for one-half of its length An incision is made parallel with and directly upon the bone, sufficiently elongated to expose freely the diseased portion which is to be removed. If it be the sternal portion of the bone, great care must be used in detaching the great pectoral muscle below and the sterno-cleido mastoid above from the surface of the clavicle. Using the back or handle of the knife, or the point of a grooved director, the entire circumference of the bone is isolated, when a chain-saw is placed around the external portion to be divided, and by cutting forward the shaft is severed. Should an ordinary saw be used, the flat handle of a scalpel or the blade of a small spatula is passed under the clavicle, which protects the important soft parts beyond, and prevents any injury from the saw. When the shaft of the bone is divided, the cut end is drawn directly forward to separate it, as far as possible, from the blood-vessels at the root of the neck. By grazing the posterior face of the bone with the edge of the knife it is denuded of all soft tissue, and a careful section of the ligaments at the sterno-clavicular junction isolates completely the bone. As the internal-mammary, subclavian, and transverse cervical arteries, with accompanying veins, and also the upper portion of the pleura, with apex of the lung, have immediate relations with the posterior border of the clavicle, this operation will not be undertaken except by those familiar with the anatomy of this region, and fully aware of the dangers to be avoided. With similar care in isolating the bone from the soft parts, the outer half of the clavicle, or even the entire bone, may be successfully removed.

Resection of the scapulo-humeral articulation.—When resection of the shoulder-joint has been deemed advisable, one of two methods might be adopted: One procedure consists in cutting up an anterior and outer flap formed of the deltoid muscle, which exposes freely the head of the bone, and facilitates excision. The other method, a perpendicular incision upon the anterior face of the joint, exposes the head of the bone with more difficulty; but as this plan does not cut up the entire attachment of the deltoid, it has its advantages. Plate 12, fig. 1, explains the method of resecting by making a deltoid flap. The arm being drawn upward and inward, the point of the knife enters the arm at its posterior portion, just in front of the posterior fold of the arm-

pit, and a little in advance of the point of perforation for Lisfranc's flap amputation. The blade glides forward over the head of the humerus, opens the capsule, and perforates the skin on the upper and anterior portion of the arm, immediately below the accromial process of the scapula: by cutting downward and outward an external flap is made of the deltoid muscle. If the head of the bone has not been altogether detached from the shaft, carrying the elbow across the chest and rotating the arm will force the head against the outer portion of the capsule, and by successive strokes of the knife, cutting through the capsular ligament and rotatory muscles attached to the tubercles of the humerus, the head will be turned out from its synovial cavity. As the elbow of the arm upon which the operation is being performed is carried upward over the chest, the head of the humerus projects from the cavity, and allows the knife to graze its inner surface and isolate it for a sufficient distance from all soft parts. A chain-saw is then passed around the bone, and by steady traction on each handle, alternately, the neck or shaft of the humerus is smoothly and rapidly divided. When an ordinary saw is used, the flat handle of a scalpel or the blade of a spatula will be placed behind the neck of the bone, to protect the soft parts while the saw is being applied. As the nervous supply of the deltoid, and also in part its nutrition, is destroyed by this flap section, atrophy and paralysis of the muscle ensue. It was on account of this sequela of resection by a deltoid flap, that a modification of the operation was suggested.

Plate 12, fig. 2, represents the method of resecting the shoulder-joint by a perpendicular incision of five or six inches in length on the anterior surface of the shoulder, commencing immediately below the accromial process and extending down to the bone, parallel with the arm, cutting through the middle of the deltoid muscle. The anterior circumflex artery, supplying the deltoid and clasping the surgical neck of the humerus, is divided in the first incision, and should be ligated. A retractor or dilator is put in the wound, and each lip of the incision drawn forcibly outward so as to expose, as much as possible, the deeper parts. If the head of the bone has been crushed, the fragments are seized with a heavy dressing or tooth forceps, and removed by isolating them from their muscular connections. As the head of the humerus is nourished solely by the vessels running through the shaft, the severing of the head from the shaft converts it into a foreign body within the joint, which must be removed. If the ball has traversed the articulation, perforating without severing the head, the length of the arm can be used as a lever, and, by rotating the head within its capsule, the various rotatory muscles attached about the anatomical neck of the bone are brought under the knife. These are cut across as exposed, the capsule widely opened by a transverse incision, and by carrying the

elbow backward, pushing it at the same time upward, the head of the bone will be dislodged. As soon as the head is freed the knife is passed behind it, and the neck isolated to the extent of the disease; a spatula is placed behind it to protect the soft parts, and the head of the bone is removed.

In the operation by a horizontal anterior incision, the wound is usually made over and parallel with the long head of the biceps muscle, which tendon should be carefully lifted from its bed in the bicipital groove and drawn to the inner side of the wound. If this tendon be divided, it impairs the usefulness of the forearm by injuring one of the principal muscles of pronation. By the anterior horizontal incision, the large posterior circumflex artery, the chief source of nutrition for the deltoid muscle, and the circumflex nerve, which also supplies it, escape injury, as they both pass under the humerus and supply the muscle from its posterior portion.

In military surgery, as resection is most frequently performed for fractures of the head and upper portion of the shaft extending into the scapulo-humeral joint, the resection consists usually in removing all spiculæ or fragments of bone, including the head, and in sawing off the spiculated extremity of the shaft smoothly. As much as five inches of the shaft and head have been removed, leaving a useful forearm and hand, and often some useful movements in the arm. In these cases in which the crushing of the neck has isolated the head, much difficulty will be found in removing this portion from the glenoid cavity, unless the protruding portion be seized with a heavy forceps resembling a straight tooth forceps, by the assistance of which the head can be rotated and its ligamentous and tendinous attachments divided.

If the resection be performed for caries or necrosis, the lip of the glenoid cavity may have become involved in the disease, and the diseased portions must be removed by a gouge or cutting bone-pliers. When all fragments have been removed and bleeding vessels ligated, the wound is closed by a sufficient number of sutures, leaving a small portion of the wound open for drainage. A large portion of the wound will unite by the first intention, but as the secretion of pus from the cavity is usually large and persists for some time, the opening left at the inferior portion of the wound discharges freely for some time. If the entire wound be brought in apposition, the collection of pus within the cavity having no means of escape, will, by internal pressure, cause agonizing pain, until it breaks through the skin. Cold water dressing and the use of diluted pyroligneous acid to correct the fœtor from the profuse discharge, comprises the local treatment. After the operation the arm is secured firmly to the trunk, so as to restrict all movements in it, inasmuch as any motion in the cut extremity of the bone produces severe pain. This bandage should only be removed when it becomes loosened

or much soiled with pus, and when renewed the arm must be held firmly while the bandage is taken off and reapplied. The general treatment will differ in no respect from that recommended for all extensive suppurating wounds, viz: opium to allay pain, and good strong food, with stimuli, to support the system.

Resection of the elbow-joint is considered a preferable operation to amputation of the arm, as it is less fatal in its results, and saves a useful extremity. This operation is applicable in military surgery to all fractures involving the joint, the portion of bone removed being confined to that injured. It must be remembered that the elbow-joint is composed chiefly of the two bones, humerus and ulna, the radius entering but little into the formation of this articulation. When the arm is extended the olecranon process of the ulna, playing around the trochlea of the humerus, closes in the back of the joint. The bones are held in apposition by strong lateral ligaments, the strength of the articulation in front depending upon the tendinous fibres of the biceps and coraco-brachialis muscle, while the attachment of the triceps muscle to the olecranon process of the ulna protects the joint from the back. The arteries which course over the posterior surface of the joint are all small muscular branches, the brachial artery lying in front of the arm. A large nerve, the ulna, lies upon the posterior surface of the internal condyle of the humerus, and is the only important structure liable to injury.

Two methods are recommended for resecting this joint. In one, a straight longitudinal incision, parallel with the limb and five inches in length, is made over the back of the joint, extending directly to the bone. The lips of this incision are dissected up from the soft parts, cutting always on a level with the bone. By so doing the ulna nerve will be lifted, with the soft parts, over the internal condyle, and as it will not be exposed, will escape injury. When the lips of the wound can be sufficiently drawn apart so as to expose the entire width of the joint, the tendinous attachments of the triceps muscle are cut transversely, the posterior ligament divided, and the joint largely opened by cutting off the olecranon process. This is effected by applying the saw to its base where this process of bone meets the anterior or coranoid process. The lateral ligaments are now cut through with the point of the knife, which, in connection with the bending of the joint, liberates all of the bones.

If the injury is confined to the lower portion of the humerus alone, only its irregular, broken surface is removed with the saw, in connection with the olecranon process of the ulna—the soft parts being protected by the blade of a spatula, placed between the head to be removed and the soft parts. Should the humeral extremities of the radius

and ulna also be diseased or fractured, their broken surfaces must be also removed with the saw, leaving smooth cut ends upon all the bones, instead of the sharp spiculæ which resulted from the passage of the ball. After the resection and ligation of bleeding vessels, the wound is closed by sutures. The arm, secured upon an anterior angular splint, long enough to support the extremity from the upper third of the humerus to the fingers, or bent at a right angle, is laid upon a pillow. In securing this splint the posterior portion of the elbow-joint is not covered by the bandage, so that it remains exposed for inspection and the application of appropriate dressing. Ligamentous union in time forms between the ends of the bones, and a very useful limb is preserved.

The other method of exposing the joint from its posterior surface, is by making a longitudinal incision on the outer or inner side of the back of the arm, which, commencing three inches above the joint, terminates opposite to the base of the olecranon process. The inferior termination of the incision is met by a transverse incision extending across the joint, L-shaped. If more space is required, a second incision on the inner side of the arm, and parallel with the first, forms a ⊔-shaped flap, which, when dissected up, will expose sufficiently the inferior extremity of the humerus. Should the heads of the radius and ulna be found diseased, the perpendicular incisions can be prolonged, H-like, and two square flaps dissected up—plate 12, fig. 4. In making the internal incision care must be taken not to injure the ulna nerve, which must be sought for and drawn to the outer side of the wound. Although the combination of these incisions facilitates the exposure and resection of the articulating ends of all the bones, yet it leaves a much larger wound than where the single median incision is made; nor does the soft parts upon the back of the arm give as much support to the resected joint. In securing the limb after the resection, some prefer a straight splint on the anterior portion of the arm, as exercising less tension on the wound. An angular splint is, however, found the most convenient. It requires many months, after cicatrization is completed, before the limb regains strength and usefulness.

Resection of the wrist-joint is one not often called for in gunshot wounds, and, as a primary operation, gives so little success that the operation is discouraged. As a secondary operation, for necrosis of either the carpal extremity of the radius or ulna, good results are obtained. The diseased bone can usually be exposed by a horizontal incision over the joint and parallel with the bone to be removed. If the one incision is found to restrict too much the manipulation of the surgeon, its inferior portion may be extended at right angles across the joint. When the carpal extremities of both bones are diseased and require removal, per

pendicular incisions should be made (plate 12, fig. 6) over the outer and posterior edge of each bone. The tendons of such muscles as lie in the way are carefully drawn to one side, and the bone, having been isolated of soft parts by careful dissection, is divided by a chain-saw, bone-pliers, or ordinary saw. As the main vessels lie upon the anterior face of the arm, they escape division. If the longitudinal incisions are sufficiently long, the ends of the bones can be readily removed. Should more room be required, however, a transverse incision across the back of the wrist, uniting the longitudinal incisions, will permit of a large square flap of skin being turned up. The flap should be but skin-deep, inasmuch as the tendons on the back of the wrist-joint are to be protected. All of these must be drawn aside and not divided; otherwise, the use of the hand and fingers will be destroyed. The closure of the wound, securing rest and quiet to the hand and forearm, by attaching it to a broad splint placed upon its anterior surface from the elbow to beyond the fingers, and the local treatment, are similar for all resections.

RESECTIONS OF INFERIOR EXTREMITY.

Resections of the lower extremity do not give such flattering results as similar operations upon the upper; yet, when we take into consideration the more serious operations for which these are offered, we must consider their adoption as a material advance in conservative surgery. In speaking of amputations at the hip-joint, we discouraged the amputation as one nearly invariably fatal. Resections, on the contrary, for gunshot injury to the head of the femur, where the bone enclosed by the capsule and within the cotyloid cavity is fractured, with, perhaps, injury to the acetabulum, are sometimes successful, saving a useful limb as well as preserving the life of the wounded. Some surgeons recommend that this resection be performed always as a secondary operation—the chances of a successful result being greater than when the operation is performed immediately after the injury. Two methods are offered for resecting *the hip-joint*. It must be remembered that the head of the femur is received into the acetabulum, where it is held firmly by the ligamentum teres and thick capsular ligament, surrounded by powerful muscles. The prominent portion of the femur on the outer side of the thigh is the great trochanter, from which the neck and head of the bone runs inward and upward, more or less obliquely. The gluteus maximus and medius muscles run over and are attached to the outer and upper side of the great trochanter. The short rotators and abductors, including the gluteus minimus, pyriformis, gemelli, internal obturator, etc., are

attached to the inner face of the trochanter, and into the fossa at its base. No vessels or nerves of importance run on the outer side of the hip-joint. The large arteries, veins, and nerves all pass on the inner and anterior side of the joint, and are only injured from carelessness in manipulating.

By one method, a straight incision is made upon the outer side of the thigh, six inches long, and parallel with the limb; a short, sharp-pointed knife is thrust into the upper part of the thigh, on a level with and one inch behind the anterior superior spine of the ilium. Cutting directly to the bone, the incision is extended downward over the trochanter sufficiently long not to embarrass the operator—plate 13, fig. 1. The thigh being now forcibly abducted so as to put the rotatory and abductor muscles upon the stretch, they are divided by the point of the knife, and the capsule largely opened from the outer side of the joint. By rotating the thigh a much larger surface of the capsule is brought under the knife, which facilitates the escape of the head of the bone. The ligamentum teres is now divided; the soft parts in front of the neck carefully divided so as to avoid important vessels, a chain-saw passed around the neck to be removed, and, by steady, alternate traction upon the handles, the affected portion of the bone is sawed through. When a chain-saw is not at hand, the soft parts are protected by means of a slip of wood or a spatula, and an ordinary saw applied. In compound fractures from gunshot wounds, all of the crushed portion of the bone must be removed, if it involves as much as even three or four inches of the neck and shaft. Should the acetabulum be also diseased or fractured, all the affected portion must be removed—a gouge or bone forceps being used. After the completion of the resection and ligation of the bleeding vessels, the wound is closed by sutures, leaving its inferior portion open for the escape of all secretions from the cavity. After the operation, the limb is secured upon a straight, long splint; although many surgeons prefer that the limb be brought into a straight position, and lie upon the bed or cushions, without being trammelled by splints or bandages of any kind. The progress of the case is more or less slow. Suppuration from the wound is at first profuse, and unless the pus has a free vent, infiltration may take place. By degrees this discharge diminishes, the wound heals, the patient is allowed to use crutches, and, finally, may possess so strong a limb that, with the use of a high-heel boot and a stick, he can walk very satisfactorily.

An objection having been made by some operators to the difficulty of exposing and liberating the head of the femur from its cavity by the straight incision, they have suggested many methods by which this tedious step of the operation could be facilitated. A convex flap, cut upward by transfixion, the base resting upon the outer portion of the thigh just below the great trochanter, is considered one of the most

desirable. This flap can be formed by cutting around the margin of the great trochanter horseshoe-like, the convex portion of the flap extending two inches above the trochanter. If the knife be passed down deep enough, this wound would expose the head of the femur. In making a transfixion, a narrow, sharp-pointed knife may be thrust through the outer portion of the thigh on a level with the upper part of the trochanter, the point of the knife passing from behind forward, under the gluteus medius muscle, and through the trochanteric fossa, between the great trochanter and the neck. When the knife has transfixed the outer portion of the limb a flap is made upward, which will, in cutting out, sever all the rotatory and abductor tendons attached to the great trochanter. By carrying the thigh across the sound one and rotating the knee forcibly inward, the capsule can be largely divided, the head of the bone turned out of its cavity (plate 13, fig. 2), and the saw applied. Or, the neck of the femur can be isolated and divided by a chain-saw passed around it, or by the ordinary saw, before the head is turned out of the acetabulum. The neck can then be seized with a strong, straight tooth forceps, and rotated so that the capsule and contiguous muscles can be easily divided. Should the neck of the femur have been fractured, the part protruding from the acetabulum is firmly seized by a strong forceps and rotated during the division of the ligaments. This flap incision is preferred by some surgeons, as it offers a ready escape for those secretions which will form freely in the wound. Any diseased portion of the acetabulum must be removed by the gouge.

Resection of the knee-joint.—This joint is formed by the expanded extremity of the femur above and the tibia below, the anterior face of the articulation being closed in by the patella. The lateral and crucial ligaments keep the bones in apposition, and give strength to the joint. All important vessels and nerves pass behind the joint through the popliteal space. In resecting this joint for perforating wounds followed by suppurative synovitis, or in cases of compound fracture involving the heads of the bones entering into the formation of the articulation, the patient is put under the influence of chloroform, which is now in universal use whenever operations of any kind are to be performed. With the leg flexed upon the thigh, the surgeon makes a convex incision extending across the entire anterior portion of the joint from one condyle of the femur to the other, encircling the upper border of the patella. Another curved incision of similar dimensions passes below the patella, which encloses this bone between two elliptical incisions. These incisions are continued through the entire thickness of the soft parts, and the patella isolated and removed. This exposes the entire anterior portion of the knee joint, and by cutting

across the crucial ligaments in the centre of the articulation, between the cupped cavities of the tibia and condyle of the femur, and also dividing the internal and external ligaments, the joint is widely opened, and either the extremity of the femur or tibia can be turned out of the wound and resected. Either or both bones, if diseased or injured, are resected. They are isolated from the soft parts posteriorly as well as anteriorly; a guard is placed behind the bone for the protection of the soft parts and important vessels (plate 13, fig. 3), while the affected portion of the head and shaft is sawed. In this resection it is considered advisable to remove as much of the synovial surface as possible, and when it is not necessary to resect the tibia, the semilunar cartilages, with their free synovial surfaces, lying upon the upper surface of the bone, to deepen the cups for the better reception of the condyles of the femur, should be removed. When it is remembered that the degree of deformity and shortening of the limb will depend upon the extent of the bone resected, only the crushed portion in injury, or the ulcerated surface in disease, should be removed. When a section of either or both bones is required, the saw should be so applied that the cut surface will be brought in uniform apposition to the opposing bone. After the section of the bones the soft parts are adjusted by points of suture, and the usual water dressing instituted. As rest and quiet in the limb are essential to a successful issue, a straight, broad splint is secured to the back of the leg, reaching from the buttock to the heel, and is retained until consolidation of the joint is effected. It is expected, in the successful cases, that the joint remain permanently stiffened by fusion of the tibia and femur.

Resection of the ankle-joint, like that of the wrist, is an operation sometimes required for gunshot injuries to the bones forming this articulation. Straight incisions on the lateral surface of the leg, parallel with the tibia or fibula, and extending to the inferior border of the malleoli, will give ample space for isolating the diseased or fractured extremity of either of these bones. Should more space be needed, the inferior end of the incision may be extended at right angles across the anterior surface of the bone. These soft parts being protected by a guard, a saw or chisel, as in plate 13, fig. 4, will divide the bone, when the lower fragment should be seized by a strong, straight tooth forceps, and while rotating it, the ligaments holding it to the tarsal bones can be severed.

LIGATION OF ARTERIES.

Arteries, as they course through limbs, seldom perforate muscles, but usually lie in the intermuscular spaces, accompanied by veins and nerves —the veins and arteries being enveloped in a layer of condensed cellular tissue, called the sheath of the vessels. All arteries of the largest size, such as the carotid, subclavian, and femoral, have but one vein accompanying them, which is always larger than the artery, and usually lies upon the inner or most protected side of the vessel. Arteries of the second class, as brachial, radial, ulnar, and tibial, are accompanied by two veins, one lying on either side of the vessel. A large nerve ordinarily accompanies the artery; more especially those of the second and third magnitude. It usually courses upon the outer or more exposed side of the artery, and without the sheath of the vessels; so that, in cutting down to expose an artery, when the immediate vicinity of the vessel is reached, the nerve is first found upon the outer side of the sheath, and this, as an important landmark, determines where the artery should be sought. The superficial landmarks are the muscles between which the arteries lie; also the direction of the vessels in relation to bony prominences; and their pulsation.

In the ligation of arteries, the rule is to make an incision parallel with their course, as one least likely to injure the vessel sought for. When, however, the position of the artery is doubtful from the obscurity of the landmarks, which is the case with one or two very deeply-seated vessels, viz: the glutial—it is preferable to make the incision across the course of the artery.

The exact position and direction of the artery having been determined, the skin of the limb where the incision is to be made is rendered tense by the surgeon, either by stretching it between the thumb and index finger of his left hand, or by putting the four fingers of his left hand in a straight line over the course of the vessel and making a straight incision of sufficient length, immediately in front of his fingernails. If the artery be deep-seated, the incision should extend through skin, cellular tissue, and fascia, directly to the muscles. As most arteries are comparatively superficial, this incision should not extend deeper than the skin. The proper form of knife for making the incision is a sharp-pointed, straight bistoury; and to make a clean, neat wound, the point of the knife should pass perpendicularly through the thickness of the skin, then depress the blade, making the length of incision necessary, and again elevate the blade perpendicularly before the incision is terminated, so that the skin is perfectly divided throughout its entire extent, the incision not ending in scratches upon the surface. The superficial layers of cellular tissue may now be carefully divided by the

point of the knife, or the tissue may be drawn upward by seizing it with a dissecting forceps at one of the angles of the wound. Make a hole in it by cutting horizontally, insert the point of a grooved director in this opening, slide the instrument under the cellular tissue for the entire length of the wound, and holding the knife with the edge turned upward, run its point through the entire length of the groove, which will divide completely the layer of tissue. With the point of the grooved director the cellular tissue around the vessel is torn up, which isolates the sheath of the artery. As this is usually a tough layer of membrane, too resisting to be torn, it is caught up with the forceps as before, an opening made horizontally in it, and by inserting the grooved director through this orifice the sheath can be divided upward, as was the cellular tissue.

Arteries are not nourished by the blood which runs through them, but by a distinct set of vessels called vassa vassora—vessels of small size, which ramify in the outer coat of arteries, and which are furnished from those small branches which pass in from the sheath of the vessels. This sheath, from which these small vessels are supplied, must not be torn up to too great an extent, or the artery requiring a ligature is isolated too extensively from its cellular envelopes, and the destruction of these nutrient vessels may cause sloughing of the artery and secondary hemorrhage. As a rule, only a sufficient space is made between the sheath and the artery to allow the passage of the aneurism needle armed with the ligature. The point of the aneurism needle is always entered between the vein and the artery. so as to avoid injuring the thin and delicate structure of the vein ; and as the vein is usually placed upon the inner side of the artery, the needle is always inserted from within outward. When the thread is passed under what we suppose to be the artery, it should be drawn upon, so as to raise the vessel and obliterate its calibre, while the index finger of the surgeon is thrust into the wound to determine whether the vessel still pulsates below the thread. If the pulsation is confined to that portion above the ligature only when the thread is drawn upward, with no pulsation below it, while this latter pulsation is resumed as soon as the traction upon the artery is released, we may feel assured that the proper vessel has been secured. This precaution is necessary, inasmuch as veins and nerves, instead of arteries, have been tied by operators of some experience who neglected to make use of this expedient.

Having passed the ligature under the artery—and any strong thread, whether of cotton, flax, or silk, will answer, flax being the most commonly used—the thread is tied in a single loop, and drawn firmly upon the vessel, with the intention of cutting through the two inner coats of the artery, as it is by the puckering in and final union of these coats that the artery is to be obliterated—plate 14, fig's 1, 2, 3. As the outer or

cellular coat is very tough and resisting, there is no fear of tearing this through, provided the fingers are placed in the depth of the wound before the traction upon the thread is made. The vessel should not be lifted from its bed during the ligation. The thread having been well waxed, after making one twist upon it to form the first noose, the ends of the ligature are wrapped around the little fingers of both hands until the thread is made so short that, when the index fingers of both hands are thrust into the depth of the wound, with the back of the fingers placed against each other, using the knuckles as a fulcrum, the extremities of the fingers are forced outward, and as the thread is drawn tightly over them, the noose will be firmly tied. The wax prevents the thread from slipping and relaxing its firm pressure upon the vessel. When the operator feels that he has exercised sufficient traction to obliterate the tube and sever the inner coats, he draws a second noose, which knots firmly the thread. In tying arteries, an ordinary knot suffices, provided the ligature has been well waxed: there is no necessity for twisting the ends of the thread twice, as formerly recommended by surgeons—"the surgeon's knot." One end of the thread is cut off close to the knot; the other is brought out of the wound and secured on the outer side of the limb by a piece of adhesive plaster. The wound is then closed by a sufficient number of sutures. If nicely brought together, the lips usually unite by the first intention, leaving but a small fistulous passage for the thread.

From the eighth to the sixteenth day, depending upon the size of the artery ligated, the degree of force used in cutting through the inner coats and compressing the outer, and the more or less perfect isolation of the vessel, the thread comes away, having, by its pressure, killed and softened, and caused to slough, in the line of pressure only, the coat of the artery encircled by the noose of the thread. This liniary sloughing is essential to the escape of the ligature. It is only when the sloughing is more extensive, so as to involve the inner coats which have recoiled away from the thread, that secondary hemorrhage ensues—plate 14, fig. 3. When the ligature remains on longer than the period above stated, slight traction may be daily made upon it, which will hasten its escape by increasing the irritation and ulceration in the line of ligation. The retention of the thread is often due to the want of sufficient traction upon the thread in tying the artery—not sufficient to cause the thread to cut through the inner coats and strangulate the outer one—or it may be caused by some of the neighboring tissue being included with the artery in the noose. The only plan for its safe removal, where it remains for a more or less protracted period in the wound, is to wait patiently upon it, making moderate traction upon the thread daily. Sometimes the wound heals up, hugging the thread so closely that it requires moderate traction to draw the knot through the

fistulous passage left for thread. Unless this moderate force was used, the ligature would be thought still connected with the artery.

LIGATION OF ARTERIES OF THE SUPERIOR EXTREMITY.

Consolidated Table of Ligation of Arteries, made up from Records in Surgeon-General's Office, from June 1, 1862, *to February* 1, 1864—*by Surgeon H. Baer.*

	Carotid.	Subclavian.	Axillary.	Brachial.	Radial.	Ulna.	Ext. Iliac.	Femoral.	Ant. Tibial.	Post. Tibial.	Total.	Remarks.
PRIMARY.												
Successful	...	...	..	2	3	1	...	2	...	1	9	
Unsuccessful	...	...	...	...	...	...	...	1	...	...	1	
SECONDARY.												
Successful	1	3	1	18	8	3	...	17	2	...	53	
Unsuccessful	5	4	3	4	1	...	1	20	3	2	43	
Average period at which hemorrhage set in, for which artery was ligated	18	15	17	17	13	8	...	20	15	18	...	days.
Greatest period	34	22	18	29	18	9	...	52	19	19	...	"
Least period	8	8	15	5	8	8	...	6	6	18	...	"

In ligating arteries in their course, as the surgeon can most frequently select the point at which the vessel is to be tied, he should always locate the operation upon the artery as far as possible from large branches. Immediately after the ligation, a clot of blood forms within the upper portion of the vessel, between the ligature and the first collateral branch given off from the artery. This clot prevents the weak portion of the vessel, where its coats had been cut through by the ligature, being disturbed during the cicatrization or union of these coats. Should the ligature have been applied in the vicinity of a large branch, the lymph thrown out by the vassa vassora to close up the puckered end of the tube is washed away by the current of blood; no clot forms, and secondary hemorrhage will probably occur when the ligature escapes from the vessel.

To ligate arteries in their course certain locations are preferred, and these regions must be carefully studied, so that all the relations of the arteries be clearly understood. In the upper extremity, the points of election for ligating the arteries are in the lower third of the axilla for the axillary artery, the middle of the arm for the brachial, and near the

wrist for the radial and ulna, although sometimes it is necessary to ligate either of these in the middle of the forearm, or to secure them after they have passed into the hand.

After the subclavian artery has passed under the clavicle, it is called axillary artery. It then continues through the armpit and upon the inner side of the arm as brachial vessel, until it reaches the anterior surface of the bend of the elbow; here it bifurcates into two vessels, the radial and ulna arteries, running parallel with their respective bones. When approaching the wrist the ulna vessel passes under the annular ligament on the inner side of the pisiform bone, and, after a perpendicular course of one and a half inches, forms an irregular curve in the palm, called the superficial arch, from the convexity of which (plate 15, fig. 3) branches are given off to supply the fingers, while the continuation of the vessel turns upward to meet a branch from the radial artery, and thus completes the palmar arch.

Should an injury to the inner portion of the palm cause annoying and persistent hemorrhage, *the ulna artery* can be secured by making an incision an inch in length on the inner side of the pisiform bone, cutting through skin, cellular tissue, and annular ligament, when the artery, lined by two veins, will be found lying upon the tendons passing over the anterior surface of the wrist-joint, and having the ulna nerve upon its outer or pisiform border. It should be carefully isolated from its accompanying veins, and secured. As the ligation at this point has no special advantage, it is much preferable to secure the artery above the wrist, where the pulse is usually felt. In this region the pulsation of the artery is so easily found that there can be no difficulty in determining its position. From the middle of the bend of the elbow (plate 15, fig. 3) the ulna artery, *g*, *k*, accompanied by two veins, takes a curved course. It is deeply buried in the arm, lying upon the deep flexors, and covered by the superficial layer of flexors. After traversing one-third the length of the arm in this obliquely curved course, it changes its direction to run in a straight course downward and parallel with the ulna. For the inferior two-thirds of its length it lies upon the deep flexors of the fingers, between the flexor carpi ulnaris tendon, *i*, on its outer or more exposed side, and the flexor sublimis digitorum, *j*, on its inner side. The ulna nerve lies upon the outer side of the vessel, partly covered by the tendon of the flexor carpi ulnaris muscle. When the arm is so swollen or fat that these muscular tendons can not be felt under the skin, nor the pulsation of the artery perceived, a simple rule for finding the vessel in the inferior half of the forearm would be to draw a line from the epitrochlœa to the inner face of the pisiform bone. Under this line the artery will be found. An incision from one and a half to two inches in length is made in this line, passing through the skin and cellular tissue. The fascia, which is now exposed, is pinched up at

one end of the wound, and a small orifice is made into it for the passage of the grooved director, upon which the fascia is divided. The tendon of the flexor carpi ulnaris is then drawn outward, and the artery is found lined by its veins, and having the ulna nerve upon its outer border.

When it becomes necessary to ligate the ulna artery in its upper half, as its pulsation can not be felt, the course of the vessel can always be determined by drawing a line from a point midway between the condyles of the humerus, at the bend of the elbow, to a point on the inner side of the forearm where the middle third joins the upper third of the ulna. It is at this point that the artery is usually sought. It can be found nearer the elbow-joint, but as the artery is very deeply seated, and as its exposure requires the division of the superficial flexors, it is considered preferable to ligate the humeral artery on the inner side of the biceps muscle. Where the middle and upper third of the inner border of the forearm meet, the artery, lined by its veins, has already escaped from beneath the flexor sublimis digitorum, and can be found in the intermuscular space between the flexor sublimis and flexor carpi ulnaris. An incision three inches long is made, as in plate 15, fig. 4. By successive layers the skin, cellular tissue, and superficial fascia are divided. As the artery is deeply seated, these tissues can be divided without cutting upon a grooved director. By placing the index finger in the wound upon the inner face of the ulna, and drawing it, with pressure, toward the interior of the arm, the finger will mount over the belly of the flexor ulnaris muscle, and suddenly sink into a depression, which marks the intermuscular space between this muscle and the flexor sublimis. With the point of the grooved director held firmly, the cellular tissue of this intermuscular space is torn up, the inner border of the flexor ulnaris is drawn aside, and the artery is found beneath it.

The radial artery runs a much straighter course. From the centre of the bend of the elbow it follows nearly a straight course downward, parallel with the radius, lying in an intermuscular space, having (plate 15, fig's 3, 9) the supinator longus muscle on its outer side, and on its inner side the pronator radii teres for its upper third, and the flexor carpi radialis, *s*, for the lower two-thirds of its course. In the upper half of the arm the artery, *T*, lined by its two veins, *r* and *p*, is deeply seated, yet, as it lies in an intermuscular space, its pulsation can be felt. In the lower half of its course it is so superficial that at the wrist it is only subcutaneous. In ligating this artery, an incision made in any portion of the arm parallel with and over the inner border of the supinator longus muscle, will always be over the course of the vessel. The pulsation of the artery is another guide: and a third, useful at all times, is to draw a line from the middle of the bend of the elbow to the inner surface of the styloid process of the radius. An incision in this line,

one and a half inches in length if the operation is performed in the vicinity of the wrist, or from two and a half to three inches if in the upper portion of the forearm (plate 15, fig. 4), extending through the skin and superficial fascia, will always expose the artery, with its veins. In the upper portion of the arm the artery is covered by the inner border of the spinator longus muscle, which overhangs it, and must, therefore, be drawn aside in the search.

From the insertion of the great pectoral to the bicipital ridge of the humerus, to the bend of the elbow, the main artery of the arm is called *brachial or humeral*—plate 16, fig. 11, *A*. It lies on the inner side of the biceps muscle, *D*, and corico-brachialis, *C*, lying upon the triceps and brachialis anticus, and surrounded by a number of large veins and nerves, all being enveloped in a loose cellular tissue. The median nerve, *G*, which is found in the upper portion of the arm, between it and the coraco-brachialis muscle, crosses the course of the artery in the middle of the arm, usually in front, sometimes behind the vessel, and is found upon its inner side at the bend of the elbow. *F*, the brachial vein, with *b*, the basilic vein, accompany the artery. *K*, the ulna nerve, which lies in juxtaposition with the inner surface of the artery in the upper portion of the arm, runs obliquely from it in its descent. The artery gives off but two large branches in its course, the superior and inferior profunda branches, both from the upper half of the vessel. If the arm is not very stout, the pulsation of the artery can be felt upon the inner border of the biceps muscle throughout its entire extent. When the arm is extended the median nerve lifts the skin, forming a prominent cord, which marks out the position of the vessel, and can be used as the guide to the artery. The inner border of the coraco-brachialis and biceps muscles are the satellites of the artery. In ligating the brachial artery, an incision from two to three inches in length, is made upon the inner border of these muscles (plate 16, fig. 2), cutting through the skin, cellular tissue, and exposing the muscular fibres. The fascia is divided upon a grooved director, and the search for the artery commenced from the fibres of the biceps muscle. Looking inward from this muscle, a large nerve is met, which is recognized as the median, and immediately within and behind it will be found the artery. If the incision be made upon the inner border of the biceps muscle, in the vicinity of the elbow, the artery may be found upon the muscular side of the nerve, or directly behind it.

From the clavicle to the insertion of the great pectoral muscle, the continuation of the brachial artery upward is called *axillary*. The artery lies on the anterior portion of the armpit, running under the pectoralis major and minor muscles (plate 16, fig. 4—1, 2), surrounded by veins and nerves; the chief vein, *h*, being upon its under and anterior surface, while the nerves, *c d e f*, pass upon its upper side. Throughout

this space several large branches are given off from the main trunk to supply the shoulder, back, and chest. The inferior third of the artery below the pectoralis minor muscle is the only portion upon which successful ligation is attempted. When the arm is carried outward from the body, the artery is found lying upon the inner border of the coraco-brachialis muscle, *b*, having two nerves upon its muscular side—the external cutaneous, *c*, and the median, *d*. If the space between the insertions of the great pectoral and great dorsal muscles be divided into three parts, the axillary artery will be found coursing over the junction of the anterior and middle third, where an incision, of three inches in length, after cutting through skin and superficial fascia, will find it. The incision having been made (plate 16, fig. 3) and the fascia divided upon the grooved director, the inner border of the coraco-brachialis is sought. From this border as a landmark, the cellular tissue is torn by the point of the grooved director. Searching inward, the first white cord which makes its appearance is the external cutaneous nerve; very near this appears the second nerve, the median; further inward we would find the ulna nerve; then the internal cutaneous. It is after the second nerve, or between and behind the median and ulna, that the artery will be found.

There is an operation laid down in the books for securing the axillary artery on the inner side of the pectoralis major muscle. Just before the vessel passes under the clavicle to become subclavian, the artery is so covered by its very large vein, and gives off such large branches, that the results of ligation are usually fatal, and therefore the operative procedure need not be described. In plate 20, fig. 4—1, is seen an incision, four inches in length, under and parallel with the clavicle, extending outward from the vicinity of the sterno-clavicular junction. The skin, cellular tissue, and great pectoral muscle are divided, when the vessels will be found beneath the great pectoral muscle with its large vein upon its anterior surface, both embedded in loose cellular tissue.

Through the lower region of the neck passes the large *subclavian artery*. On the right side, this vessel is one of the bifurcating branches of the arteria innominata; on the left side it arises as an independant branch from the arch of the aorta. The artery makes a curve through the neck, running from the sterno-clavicular junction to the middle of the clavicle, where it passes under this bone to become axillary, and hence the name of subclavian given to it. The artery, about five inches in length, forms a bow, of which the clavicle forms the cord. It lies deeply at the root of the neck, covered in by skin, platysma-myoid, sterno-cleido-mastoid, omo-hyoid, and scalenus muscles. This last muscle, the scalenus anticus, in making its attachment to the tubercle upon the first rib, passes over and conceals the middle third of the

subclavian artery, thus dividing it into three portions—a part within the muscle, between its inner border and the sterno-clavicular junction; a second portion behind the scalenus muscle; and a third, or longer portion, between the scalenus muscle and the upper border of the clavicle. From the inner and middle portions so many large branches are given off that it is impossible to obtain a sufficient space between the seat of ligature and one of these branches to obtain a successful result after ligation. It will not be necessary, therefore, to study the relations of these portions of the subclavian artery. It is upon the outer portion of the vessel, after it has escaped from between the two scaleni muscles, that successful ligations are practised. Usually no branches arise from this outer third of the vessel. The subclavian vein (plate 20, fig. 3, *B*) accompanies *A*, the subclavian artery, being upon its anterior face, and separated from it by the anterior scalenus muscle—the artery passing behind the vein, which lies in front of this muscle. No nerve accompanies immediately this artery, although the entire brachial plexus of nerves, *D*, issuing from the four inferior cervical foraminæ, pass to the arm at a short distance from the outer border of this vessel. Both artery, vein, and nerves are found in a deep triangular space bounded below by the clavicle, and on the inner side by the external border of the sterno-cleido-mastoid, 4, or the anterior scalenus muscle. The upper and outer boundary is formed by the omo-hyoid muscle, 5; the outer directly by the trapezius muscle. The immediate guide for finding the artery is the tubercle upon the upper face of the first rib, upon which prominence is attached the scalenus anticus muscle.

In ligating the subclavian artery at its outer third, which is the only practicable portion, the shoulder to be operated upon must be depressed, the face being turned away from it. The skin of the neck is drawn down, parallel with the clavicle, for half an inch, and an incision outward, three inches in length, is made on the upper edge, and parallel with the clavicle, extending from the external border of the sterno-cleido-mastoid muscle to the anterior border of the trapezius muscle. The incision at first passes through the skin alone. At its inner angle is seen the external jugular vein, passing down on the outer border of the sterno-cleido-mastoid muscle to empty into the subclavian vein. This vessel, when exposed, is drawn to the inner side of the wound. Should it have been injured in the first incision, two ligatures are applied to it, and the vessel divided between them. The next tissue divided is the platysma-myoid; then the cervical fascia, divided upon a grooved director. As all of the resistant tissues have now been divided, a grooved director is substituted for the knife, and by holding it firmly near its point, the cellular tissue is torn by the to and fro movements which isolate the vessels. The index finger can very well effect this tearing of the cellular tissue. Should the knife be used for this purpose, the supra-scapular

artery, which runs from the inner half of the subclavian outward, parallel with the upper border of the clavicle, may be injured. Having now free access to the depth of the wound, the left index finger of the surgeon is thrust into the wound, the pulsation in the artery found, and the tubercle upon the upper face of the first rib sought. When found, the finger is kept upon it to mark its situation, while an aneurism needle is guided by it to the depth of the wound, and by placing the blunt point of this needle in front of the outer border of this tubercle and scraping it upon the rib immediately from before backward, the artery is hooked up, as it is the only structure lying upon the rib upon the outer side of the tubercle—plate 20, fig. 4—2. The vein is separated from the artery by the thickness of the scalenus muscle, and therefore can not be included in the ligature. Should the point of the needle not be retained in contact with the tubercle of the rib, but be allowed to wander about the wound, one of the brachial plexus of nerves will most probably be hooked up. The aneurism needle having been threaded before it was applied, one end of the thread is drawn out of the eye upon the outer side of the vessel, and by drawing the instrument backward, the exposed thread being held, the other end is drawn out of the wound with the needle, leaving the ligature under the artery. By drawing slightly upon this it can be readily determined whether the artery is over the thread or not, as the pulsation in it would be stopped by the pressure. Feeling assured that the artery alone has been secured, the ligature is firmly tied by thrusting the fingers deeply into the wound. One end of the ligature is cut off close to the knot, the other brought out of the wound, and the incision closed by sutures.

Ligation of the common carotid.—In examining the outer surface of the neck, when the shoulder is drawn downward, the jaw thrown upward, with the face toward the opposite shoulder, a muscular ridge is seen running diagonally across the neck from the sternum below to behind the ear above. This ridge is the sterno-cleido-mastoid muscle, which, from its position, divides the neck into two triangles. One, bounded by this ridge, the anterior median line, and the lower border of the jaw, is the anterior cervical triangle, which contains the carotid artery and all of its important branches. In the outer triangle bounded by this ridge, the clavicle, and the anterior border of the trapezius muscle, lies the subclavian vessels. If the neck be dissected, so as to expose the vessels by the removal of the skin, cellular tissue, platysma-myoid muscle, and cervical fascia, the lower portion of the sterno-cleido-mastoid muscle will be found to cover all of the vessels, the common carotid artery being deeply seated at the root of the neck. About the middle of the neck the carotid vessel appears from beneath the inner border of the muscle, lying in a groove between the trachea

and larynx in front and the vertebral column behind, having, in the cellular sheath which envelopes the vessel, the large internal jugular vein upon its outer and anterior surface, and the important pneumogastric nerve between and behind the artery and the vein. A branch of the hypo-glossal nerve, called the descendens noni, lies in front and upon the sheath of the vessel, while behind the sheath is the sympathetic nerve. If the sterno-cleido-mastoid (plate 20, fig. 1—3) be removed, this anterior triangle of the neck is found subdivided by the oblique position of the omo-hyoid, 2, forming an inferior and a superior triangle. In the lower triangle the common carotid vessel, *A*, plate 20, fig. 1, is deeply seated, accompanied by the internal jugular vein, *B*, and pneumogastric nerve, *C*. No branches are given off from it. In the upper triangle it becomes more superficial. Here its pulsation can readily be felt, and, as the vessel is nearly subcutaneous, can also be seen. When the common carotid reaches the level of the thyroid cartilage it bifurcates into two vessels, the internal and external carotid. The internal becomes again deeply seated, entering the skull through the temporal bone. The external commences at once to give off branches, the first of which, the superior thyroid, runs obliquely downward and forward, to be spent upon the thyroid gland, on the anterior surface of the trachea. A second, the lingual, runs outward, parallel with the hyoid bone, to be spent in and about the tongue. A third, the facial, *E*, runs an obliquely upward and forward course over the lower-jaw, to be distributed upon the face. The continuation of the external carotid upward terminates finally into two branches, the internal maxillary, which passes on the inner side of the head of the lower jaw, and is the artery often injured in the removal of this bone; and the temporal artery, coursing upward, in front of the ear, to be distributed to the anterior portion of the scalp.

In ligating the common carotid artery, the sterno-cleido-mastoid muscle is used as a guide to find the artery. The vessel, at its origin, lies under this muscle, but always escapes from beneath its inner border at the middle of the neck, and then courses upwards to the lower jaw, in the direction of and nearly parallel with its inner border. The chest being raised by a pillow placed between the shoulders, head depressed, and face turned toward the opposite shoulder, with angle of jaw turned upward, so that a strong light falls upon the neck, an incision, three inches in length, is made upon and parallel with the inner border of the sterno-cleido-mastoid muscle (plate 20, fig. 2, *a*). It passes through the skin, cellular tissue, platysma-myoid muscle, and superficial fascia, exposing the fibres of the sterno-cleido-mastoid muscle, which are at once recognized, as they run always in an oblique direction, *upward and backward*. The only other muscle which may confuse the operator is the platysma-myoid, the fibres of which run always *upward*

and forward. It is always preferable to cut down upon rather than at the inner side of the sterno-cleido-mastoid muscle. as, when exposed, it can be used as a sure guide; and also, by its thickness, protects the vessels, etc., beyond it. When the deep layer of cervical fascia is divided upon the grooved director, the inner border of the muscle is drawn outward by an assistant, when, with the finger, the pulsation of the artery can be felt under its sheath, upon which can now be seen a small white thread—the descendens noni nerve. The cellular tissue forming the sheath is carefully picked up by a forceps, and opened by the point of the knife held horizontally: great care being taken not to mistake the structure of the vein for the sheath—the latter will be known by its dark appearance when filled with blood—nor should the small nerve upon the sheath be injured. Upon a grooved director, carefully inserted, the sheath is divided. With the point of the director the vein is separated from the artery, using a forceps, upon the contiguous sheath and not upon the vein, to steady the parts while the cellular connections between the vessels are torn. An aneurism needle, threaded, is now passed from without inwards around the artery—care being taken not to include the pneumogastric nerve, which lies between and behind the vessels, nor the descendens noni, which runs on the anterior surface of the sheath. The needle should always be entered between the vein and artery, and by a winding or worming movement is made to work its way through the cellular tissue forming the bed of the vessel. After the thread is passed under the vessel it must be drawn upon, to determine whether it has been applied to the artery, which is proved by the pulsation ceasing below it. The vessel is then tied firmly by thrusting the fingers into the wound and making traction against the pulps of the two index fingers. One end of the ligature is cut off near the knot, the other secured to the surrounding skin of the neck under a piece of adhesive plaster, and the wound closed by sutures.

When it is necessary to ligate the external carotid artery, a similar incision, extending upward, but still upon the inner border of the sterno-cleido-mastoid muscle, will equally expose the vessel in the vicinity of the posterior extremity of the hyoid bone, where either the common trunk, the internal, or external carotid can be ligated.

Some of the branches of the external carotid sometimes require ligation, either from the direct effects of injury, or from secondary hemorrhage.

The *superior thyroid artery*, the first branch given off from the external carotid, can be exposed in the wound for the ligation of the common carotid at its bifurcation. The artery lies between the sheath of the carotid vessel and the lateral lobe of the thyroid gland, where it can be found.

The lingual artery is so deeply seated, covered by the hyoid and lingual muscles, that its pulsation can not be felt. The guide for this vessel is the upper border of the hyoid bone, parallel to which, and half an inch above it, an incision of one and a half inches should be made. This incision extends through the skin, platysma-myoid, and cervical fascia, which exposes the tendon of the digastricus muscle—plate 20, fig. *b—a*. The incision is continued above this tendon through the hyo-glossus muscle, under which the artery is found resting upon the genio-hyo-glossus muscle, and accompanied by the hypo-glossal nerve. *The facial artery*, as it runs over the lower jaw in front of the masseter muscle, can be readily felt and secured by making an incision parallel with the anterior border of the masseter muscle, the vessel lying very superficially. In front of the ear the *temporal artery* can be readily felt, where its course is subcutaneous over the posterior and outer edge of the zygomatic arch. An incision of one inch in length, passing through the skin, will expose the artery embedded in a condensed cellular tissue.

In cases where persistent hemorrhage occurs from the passage of a ball implicating any of these vessels, it is preferable at all times to enlarge the wound, seek the bleeding vessel, and ligate it in situ, rather than ligate the main vessel, which should always be considered a *dernier resort*.

LIGATION OF ARTERIES OF THE INFERIOR EXTREMITY.

In the inferior extremity we find a similar distribution of blood-vessels to that of the superior limb. The artery which passes through the pelvis as iliac, becomes femoral as it courses through the thigh, then popliteal behind the knee, where it divides into two main trunks. One perforates the upper portion of the interosseous membrane between the tibia and fibula, to become anterior tibial, running down to the foot as dorsalis pedis: the other passes through the back of the leg as posterior tibial vessel, and running behind the inner malleolus supplies the plantar muscle as plantar artery. Soon after its origin the posterior tibial artery gives off a large branch—the peroneal artery—which runs down the limb on the inner and posterior border of the fibula, passing into the sole behind the external malleolus.

In examining plate 17, fig. 1, *the dorsalis pedis artery*, the continuation of the anterior tibial vessel, A, is seen running superficially upon the back of the foot, having passed beneath, 1, the annular ligament. Its course is a straight one from the middle of the space between the two malleoli to the intermetatarsal space between the first and second toes

The artery, accompanied, as usual, by two veins and a nerve, lies in an intermuscular space upon the deep extensors of the toes, 4, having the long common extensor of the toes, 3, upon its outer border, and the proper extensor of the big toe, 2, upon its inner side. The guide for ligating this artery is either to make an incision (plate 17, fig. 2) upon the outer side of and parallel with the tendon of the extensor proprius pollicis—which tendon, when put in action, forms a cord under the skin, upon the anterior and inner side of the foot—or in a line drawn from the middle of the instep to the interspace between the big and second toe. An incision through the skin and cellular tissue at once exposes the vessel. Should any doubt arise as to its exact locality, by searching from the outer edge of the tendon of the proper extensor of the big toe the artery can always be found.

The anterior tibial artery (plate 17, fig. 3, *A*), accompanied by its veins, *B B*, runs nearly a straight course upon the anterior surface of the interosseous membrane, being very deeply seated above, but becoming more superficial as it descends, until at the instep its position over the anterior face of the inferior extremity of the tibia is nearly subcutaneous. In the upper half of the leg the anterior tibial artery, *A*, lies deeply in the intermuscular space formed by the body of the tibialis anticus muscle, 4, upon the inner side, and the extensor communis digitorum pedis, 6, upon the outer side. The tibial nerve, *C*, here lies upon the outer side of the artery. In its lower half the artery is placed between the tibialis anticus muscle, 4, and the extensor pollicis pedis, 8, the anterior tibial nerve, *c*, lying often upon the anterior face of the artery, and, at times, even gaining its inner border.

In ligating the anterior tibial artery in any portion of its extent, several guides can be used. One of these is the tendon of the tibialis anticus muscle, which, when put upon the stretch, forms a prominence under the skin of the leg; an incision made upon the outer border of this cord-like prominence will always find the artery. Another guide is to allow a certain thickness for the belly and tendon of the tibialis anticus muscle, and make the incision correspondingly, which allowance, in a fleshy subject, should be three fingers' breadth from the anterior edge of the tibia in the upper third of the leg; two fingers' breadth in the middle, and one finger breadth in the lower third of the leg, where the tendon alone separates it from the tibia. Still a third guide is a straight line drawn from a point midway between the head of the fibula and anterior spine of the tibia, and a point midway between the malleoli. An incision made in any portion of this line will expose the artery. Using any of these guides (for they all correspond with each other), an incision is made (plate 17, fig. 4—2) four inches in length, in the upper part of the leg, extending through the skin, cellular tissue, and aponeurotic fascia which binds down the muscles. As the longitu-

dinal incision through this fascia is usually not sufficient to allow of a free search, a cross incision is made into it, extending from the spine of the tibia outwards, one inch in length. The intermuscular space not being clearly defined in the upper portion of the leg, is readily determined by placing the index finger in the wound with the tip resting upon the spine of the tibia. As the finger is drawn outward, pressing at the same time upon the muscle, a mass of muscular tissue, the belly of the tibialis anticus, is felt to roll away from the finger, which at once sinks into a depression or groove corresponding to the intermuscular space between this and the common extensor muscle. With the grooved director or index finger the two muscles are separated in this gutter, and after passing to the depth of nearly two inches, the artery, with veins and nerve, are found lying upon and intimately connected to the interosseous ligament. With the point of the grooved director the artery is isolated from the accompanying veins for a sufficient distance, one or two lines, to allow the passage of the aneurism needle, armed with a ligature. As there are no vessels of any size to be divided in this operation, the incision can be bold, and the operation is comparatively a dry one, without loss of blood. In the lower portion of the leg the operation is conducted in the same way. After an incision of two to three inches in length through the skin and (plate 17, fig. 4—1) superficial fascia, the finger is placed upon the spine of the tibia and drawn outwards. When one cord escapes, we know that it is the first and only muscle intervening between the bone and the artery, and, therefore, upon its outer side we will invariably find the vessel.

The posterior tibial artery also runs a straight course upon the back of the leg, lying deeply embedded in the upper half of the limb, between the deep and superficial layers of muscles. Approaching the surface as it descends, when near the ankle, it lies under the skin and fascia, without muscular covering. From its origin in the inferior portion of the popliteal space, the posterior tibial artery (plate 18, fig. 1, *A*) lies under the calf muscles, 5, composed of the gastrocnemii and soleus, uniting to form below the tendo achillis, 6. The artery, accompanied by two veins, *B*, one on either side, and the posterior tibial nerve, *c*, lies beneath the deep fascia, and upon the deep flexor muscles of the foot and leg. To expose the artery in the upper half of the leg, the soleus muscle must be detached from the inner border of the tibia and drawn outward with a hook, as in fig. 1, 5. As the artery in its descent appears from beneath the inner border of the soleus muscle, becoming comparatively superficial, it lies in the intermuscular space between the tendo achillis, 6, and the flexor communis digitorum, 8, the tendon of which muscle, in reaching the sole of the foot, passes through a sheath behind the inner malleolus, 2.

To ligate this vessel, the leg is placed on its outer side. with knee flexed, and an incision is made parallel with and one inch from the inner and posterior border of the tibia. if the ligation is performed in the upper half of the leg: and midway between the tibia and tendo achillis, if in the lower. As the posterior tibial artery passes into the foot, it can be found midway between the internal malleolus and the bony prominence upon the inner border of the os calcis, in the centre of the hollow of the heel. In the lower portion of the leg the incision should be two and a half inches in length (plate 18, fig 2—1), extending through the skin, cellular tissue, and fascia. When the deep fascia is divided upon the grooved director, and the finger thrust into the wound the exact position of the vessel can be discovered by its pulsation, and by means of the end of the grooved director it can be sufficiently isolated for the passage of the aneurism needle, from its contiguous veins and posterior tibial nerve, which lies upon its outer side.

In the upper half of the leg the artery is much deeper seated, lying between the deep and superficial layers of muscles, under the deep fascia of the leg and under the middle of the calf. As from the depth of the wound and the inconveniences of cutting through the centre of the calf, both from injury to the muscles and from the accompanying hemorrhage, it would be improper to cut down directly upon the course of the vessel, an incision of four inches, or even more, in extent, is made upon the inner side of the leg (plate 18, fig. 2—3), parallel with and one inch from the posterior border of the tibia. The incision is made boldly through the skin and cellular tissue to the muscular fibres of the soleus muscle. Detach this muscle from its connections with the tibia, and have its border drawn backwards (plate 18, fig. 1—5). If the wound be thoroughly cleansed, the vessels can be seen as well as the pulsation in the artery felt, under the deep fascia, having a vein on each side, and the tibial nerve upon its outer border. This deep fascia is divided upon a grooved director, the vessel isolated, and the aneurism needle, armed with a ligature, passed. This operation, owing to the depth of the wound, is one of the most troublesome and tedious of the ligations.

The fibular or peroneal artery, an external and posterior bifurcation of the posterior tibial, descends vertically along the posterior and internal border of the fibula, throughout its entire length, being deeply seated, covered in by the soleus muscle above and by the tibialis posticus and proper flexor of the great toe in the lower half of its course. To ligate this vessel the leg is placed upon its inner surface, and an incision of four inches in length is made parallel with and one-fourth of an inch from the external border of the fibula. This incision extends through the integumentary tissues down to the muscle. If the operation is performed in the upper half of the leg, the soleus muscle must be de-

tached from its fibula connection and drawn outwards, which exposes the flexor longus pollicis. Detach this muscle from the fibula and draw it outwards, when the peroneal artery will be found at its inner border, lying upon the bone near the attachment of the interosseous membrane (plate 17, fig. 4—3).

The femoral artery requires from us particular attention, as its ligation is more frequently required, both in civil and military surgery, than that of any other artery. The main artery running through the thigh is called femoral from the groin to the knee. The abdominal aorta, opposite to the body of the fourth lumbar vertebra, bifurcates into two large vessels, which run off obliquely from the main trunk. These are the common iliacs, which, after a course of two inches, when they reach the vicinity of the sacro-iliac symphysis, subdivide into two other vessels, the external and internal iliacs. The external iliac continues onward around the brim of the pelvis until it passes from the abdomen, beneath Poupart's ligament, when it is known as the femoral artery. Its course is still a straight one, shooting down the limb, leaning to the inner border of the thigh, and finally winding around and behind the femur, where, as popliteal artery, it is found behind the knee-joint. Throughout its entire course it is accompanied by a very large vein, the femoral vein, which is always placed upon its inner border, and by a nerve, which lies on its outer side.

In examining more particularly the relations of the femoral artery, we find that the vessel, with the femoral vein upon its inner side, and a large plexus of femoral nerves upon its outer side, passes out from beneath the femoral arch, midway between the anterior superior spinous process of the ilium and the symphysis pubis. At this point the pulsation of the artery can be distinctly felt, as it lies upon the pelvic bones, separated from them only by the psoas and iliacus muscles, which form a soft bed for the vessel. The artery is here quite superficial, covered only by skin, cellular tissue, and the fascia lata of the thigh. No muscular pad covers the vessel: hence the facility of arresting the circulation through the thigh by pressure at this point whenever operations involving the vessels are practised upon the inferior extremity. Plate 14, fig. 6, shows how pressure is to be made by applying both thumbs to the pulsating vessel. After its escape from beneath Poupart's ligament, the femoral artery, throughout its course through the thigh, is placed in certain relations with the thigh muscles. The sartorius muscle, running obliquely from the outer portion of the hip to the inner part of the knee, where it is attached to the inner face of the head of the tibia, is called the satellite of the artery. In the upper fourth of the thigh the artery lies on the inner side of the muscle. In the second fourth, as the muscle runs much more obliquely inwards than the artery, it covers over the vessel, which, in this part of the thigh, lies under the

muscle. In the third portion of the thigh the artery is actually placed upon the outer side of the muscle, inasmuch as the sartorius has run over the artery, and is now found upon the inner side of the vessel. In plate 19, fig. 2, the sartorius muscle is hooked up and drawn outwards, to show the vessels running under it.

In the upper third of the thigh, as the femoral artery is most superficial, this position is most frequently selected for the application of the ligature. The space is called the triangle of Scarpa, and has long been the seat of election for tying the femoral artery. The boundaries of this space are the sartorius muscle, which forms a prominent ridge upon the outer and anterior border of the triangle. The inner border is formed by the adductor longus muscle, which is attached above to the pubis, and below, upon the middle of the rough line of the femur. The base of the triangle is formed by Poupart's ligament, 1. Even before the skin is dissected off from the upper part of the thigh, the outlines of the triangle can be well discerned. The line of the groin forms the base; the oblique ridge upon the anterior portion of the thigh the outer border of the triangle; the inner ridge of the thigh the inner boundary; and where these two ridges intersect each other is the apex. If a line be let fall from this apex, perpendicularly to Poupart's ligament, it will lie, throughout its entire extent, over the course of the femoral artery. The artery, *A*, will be accompanied on its inner side by the femoral vein, *C*, which adheres more or less intimately to the artery, being separated from it by a prolongation of the fascia lata; and separated from the artery also by a prolongation of the fascia lata, is a large package of anterior femoral nerves, *E*. From one to two inches below the fold of the groin the femoral artery gives off a very large branch, the profunda femoris, which at once buries itself in the muscles of the thigh to supply them with nutrition. The femoral vessel proper, after this bifurcation, passes onward to the knee, giving off no branches of importance until it becomes popliteal, when it commences through the terminal branches, which we have already studied, as tibial vessels, to supply the leg and foot.

In ligating the femoral artery in Scarpa's triangle the position of the profunda must be remembered, as the ligature should be applied at either some little distance above or below this vessel, and not at the bifurcation. The outlines of the triangle must be clearly mapped out, and the perpendicular drawn from the apex of the triangle to the centre of Poupart's ligament, which line will correspond to the pulsation of the artery, and also to a line which will mark out the course of the artery when the limb may be so swollen or fat that the muscular prominences may not be discernible. This line, which lies over the entire course of the femoral artery, is one drawn from the middle of Poupart's ligament, or from midway between the anterior superior supinous process

of the ilium and the symphysis pubis, to a point midway between the condyles of the femur behind the knee, the line encircling obliquely the inner portion of the thigh. An incision from three to four inches in length is made upon this line, as it passes through the centre of Scarpa's triangle—plate 19, fig. 3. This incision, after passing through the skin and cellular tissue, exposes a superficial vein called the internal saphenous (plate 19, fig. 2, *d*), which, running up from the foot and leg, courses upon the inner surface of the thigh, and one and a half inches below the fold of the groin enters an orifice in the fascia lata, the saphenous opening, to empty directly into the femoral vein. This vein must not be injured. The fascia lata, upon its outer side, is pinched up and divided upon a grooved director, which exposes at once the sheath of the vessel. With blunt hooks the lips of the wound are drawn asunder by an assistant, when the surgeon, feeling the pulsation and seeing the vein and artery, by the careful use of the end of the grooved director separates the vein from the artery for a sufficient extent to pass the threaded aneurism needle between the vein and artery, with point directed outward, and hooks up the artery. Isolating the artery from all nerves, and feeling assured that the ligature passes under it, the thread is tied, and the case treated as usual, by closing the wound by sutures, and applying water dressing to ensure quick union.

Whether that portion above or below the origin of the profunda requires a ligature, the only difference in the operation consists in the position of the wound upon the line indicated—the envelopes of the artery, and its relation, both to the femoral vein and crucial nerves, being practically the same in both situations.

When we are called upon to tie the femoral artery at the junction of the upper and middle thirds of the thigh, we either cut in the imaginary line drawn from the middle of the groin to the middle of the back of the knee, or if the sartorius muscle is sufficiently prominent, an incision of from three to four inches in length is made directly upon this muscle, exposing its fibres by cutting through skin, cellular tissue, and fascia. We recognize the muscle immediately by the direction of its fibres, as no other superficial muscle of the thigh has fibres running obliquely downward and inward. Knowing exactly where we are by the direction of these fibres, they are all drawn to the outer side of the wound, when the femoral artery, vein, and two accompanying nerves, will be found under its inner border, covered over by a layer of fascia lata and the proper sheath of the vessels.

The two nerves which accompany the artery are the internal cutaneous and the long saphenous. When the artery passes through the tendon of the adductor muscle, at the junction of the middle and inferior thirds of the inner face of the thigh, it is still accompanied by the long saphenous nerve, which passes under the tendinous bridge with it, while

the internal cutaneous passes over the bridge, and, as its name implies, is distributed to the skin of the inner portion of the leg.

Although seldom required, there are instances in our military experience where, from injury to the femoral vessels in the groin, a ligature to the *iliac artery* is deemed necessary. Plate 19, fig. 1, will exhibit to us the relations which the external iliac artery bears to its surroundings. The entire length of the external iliac is not over five inches, extending along the rim of the pelvis from the sacro-iliac symphysis to Poupart's ligament. As it approaches its termination it gives off two large branches, the epigastric and the circumflex arteries. On its inner side lies the iliac vein, and without a number of crural nerves. All of these structures lie upon the psoas and iliac muscles, covered by transversalis fascia and peritoneum. In exposing the artery, an incision three to four inches in length is commenced over the point where the pulsation of the artery is distinguished as it runs over the brim of the pelvis, being parallel with and half an inch above Poupart's ligament, and terminates two inches above the anterior superior spine of the ilium. The incision extending through the skin, superficial fascia, the tendon of the external oblique muscle, and the internal and transversalis muscles, all of which are incised upon the grooved director for safety, exposes the transversalis fascia.

The wound is now dilated with the two index fingers of the surgeon separating the cellular tissue, and pushing inward and upward the peritoneum, which he dissects by tearing it from the transversalis fascia. When the separation is carried sufficiently far, the operator, keeping back the peritoneum with the index finger of the left hand, thrusts the forefinger of the right hand into the wound, feeling for the brim of the pelvis and the pulsation of the iliac artery. As soon as permitted, the wound being well dilated, the operator scratches through the loose cellular sheath of the vessels, and passes the threaded aneurism needle from within outward, the point being first inserted between the vein and the artery, to avoid injuring the delicate coats of the former. One end of the thread is drawn out of the wound; the withdrawal of the needle with the other end of the thread encircles the vessel. Being quite sure that the artery alone is surrounded, the thread is tied by passing the forefingers deeply into the wound, and making traction upon the noose without lifting the artery from its bed. One end of the thread is cut off close to the knot, the other drawn out and secured safely upon the abdominal wall, the wound being closed by sutures, as in all instances, and the usual cold water dressing applied.

TREPHINING.

In compound fractures of the skull, where the bones are much spiculated, it has been already recommended to remove all loose fragments at the first dressing. Should the skull have been driven in, depressed, with accompanying symptoms of stupor, resulting apparently from the direct pressure of the fragments upon the brain, it is sometimes thought expedient to lift the depressed portion of bone and relieve, if possible, the symptoms of compression. This operation is effected by enlarging the wound of the scalp. A crucial incision—two lines crossing each other at right angles—is made over and directly to the depressed bone, and the four corners are dissected up as in plate 21, fig. 2, *a a a a*, which exposes the skull covered by periosteum. An incision is made into this membrane, which is so intimately attached to the bone that it must be scraped off from a sufficient space to allow the application of the trephine. This instrument is a circular saw, a section of a cylinder with the saw-teeth arranged upon its free end, working upon a central movable pivot. An improvement, which consists in making the body of the instrument a truncated cone, with teeth upon the side as well as upon the end, has been attributed to Mr. Galt, of Virginia; but drawings strikingly similar can be found in Heister's Surgery, published in London, 1757, which Heister in the text speaks of as "the trephine which I use." The advantages which the conical trephine possesses over the cylindrical is, that the pressure in cutting is borne mostly upon the rim of the skull and not upon the fragment which is being removed, and therefore there is much less danger of wounding the membranes and brain.

When we have a choice in the position, we would not place the trephine over the anterior inferior angle of the parietal bone, for fear of injuring the meningeal arteries, *a a a* (plate 21, fig. 1), which often lie deeply embedded in grooves traced upon the inner face of this bone; nor over the lateral and longitudinal sinuses, which are seen in the same figure—*c d*, and *b b b*.

When the trephine is used to relieve accumulations of fluid within the skull, it should be applied directly over the supposed seat of the fluid. When used to assist in the elevation and restoration of depressed bone, the point or axis of the saw is placed upon the contiguous edge of uninjured bone, so that the circular saw, in its rotary movements, will cut out a small segment of the depressed bone and a much larger piece of the healthy skull.

The surgeon, holding the handle of the instrument firmly, as in plate 21, fig. 2, with index finger placed upon the crown of the instrument to steady it, and point or axis protruding a twelfth of an inch, commences by rotating

the wrist, and with it the instrument, so as to bore into the skull and bury the pivot. Upon this as an axis the saw-teeth revolve, cutting a groove in the bone. When this groove is sufficiently deep to confine the instrument and allow it to continue its rotatory motion without the use of the axis, the pivot is drawn within the cylinder, so that all injury to the membrane by this perforating point will be avoided. After cutting deeply into the skull, the bottom of the groove should be examined by a probe or quill, to determine which portion of the bone has been cut through. The sensation imparted through the quill can readily detect the hard, undivided bone from the membranes beyond the cut portion. When the trephine is reapplied, pressure must be only made by the rim of the saw upon that portion of the bone not yet cut through. When it is found that nearly the entire crown has been cut through, the trephine is removed and the end of a lever placed in the groove, by the use of which the round piece of bone is lifted from its position. Through the opening the one end of the lever can be easily applied beneath the depressed bones, and, bearing down upon the long arm of the lever, using the rim of the opening in the uninjured bone as a fulcrum, the depressed fragments are prized up into place—plate 21, fig. 4. Should large pieces be found quite detached they should be removed (fig. 3), as they will die, having had their nutrition destroyed. Should the dura mater and brain beneath be in a healthy condition, the dura mater will retain its natural level, the pulsating of the brain being clearly seen. If the operation has been performed to relieve the effects of pressure produced by the accumulation of fluid under this membrane, it will at once rise up, filling the trephine hole, when the round piece of bone is removed, and no pulsation will be transmitted through it. Under these circumstances it will be necessary to incise the dura mater, to allow the pent-up fluids compressing the brain to escape. When the operation has been completed, the flaps in the scalp are closed by suture, and cold water dressings applied.

HYDROCELE.

Hydrocele, a disease very common in the army, consists in an accumulation of fluid in the scrotum, being contained in the cavity of the tunica vaginalis. The enlargement formed of the scrotum is round or oval, uniformly hard, yet always possessing fluctuation. It is distinguished at once from hernia by being confined altogether to the scrotum, the cord where it passes into the abdomen being soft and of its usual size. As all herniæ come from the abdomen, such tumors always commence from above, and as they gradually become scrotal they must

always have their enlarged, stout neck leading directly into the abdomen.

Hydrocele is distinguished from diseases of the body of the testicle, by the latter being irregularly hard and inelastic, also feeling heavy when the mass of the swelling is supported in the hand. In hydrocele the skin is seldom involved, while in diseased and enlarged testicles the skin is usually red and quite sensitive. Tests, to detect fluctuation in painless, uniformly enlarged scrota, in which the increase in size has been slow, without symptoms of inflammation, I have found best applied as follows: I usually seize the body of the swelling between the index finger and thumb of the right hand, while the upper portion of the swelling is held firmly between the index finger and thumb of the left hand. By alternately squeezing with the right hand, then with the left, the fluid displaced by one hand will be felt to force asunder the fingers of the other. I have found this a very simple and successful test for hydrocele. In the posterior portion of the swelling will always be felt a hard mass, which is the testicle. The tunica vaginalis, as it is reflected from the scrotum to the testicle proper, leaves in front of it a sac in which the serous fluid collects. As it accumulates it forces the testicle away from the anterior wall of the scrotum, and removes the dangers of injuring the testicle during the operation for tapping the sac and drawing off the fluid accumulation.

The method for tapping a hydrocele is as follows: The left hand of the surgeon seizes the upper portion of the enlarged scrotum, grasping (plate 22, fig. 1) the entire circumference of the tumor, forcing the fluid into the lower portion of the sac, and stretching the skin of the scrotum over the tumor. This position, by forcing the fluid between the testicle and the anterior wall of the sac, renders the puncture of the testicle impossible, if the instrument be properly directed. With a small sharp trocar and canula, held between the thumb and second finger, the handle butting against the base of the thumb, and with index finger upon the stem, guarding the depth to which the instrument should be thrust into the scrotum, the point of the trocar is placed upon that portion of the anterior and inferior portion of the tumor devoid of large veins, and, by a forward and sudden movement of the wrist, the instrument is thrust obliquely backward and upward, in a direction somewhat oblique to the long axis of the swelling. As soon as the surgeon feels the resistance cease, or that the point of the trocar has passed through the walls of the scrotum and lies in the cavity of the tunica vaginalis, he draws out the trocar, while the canula is pushed forward well into the cavity. As soon as the trocar is drawn out a clear serum escapes in a stream, the cavity is rapidly emptied, and the swelling disappears.

This tapping of the sac is only a palliative remedy; for, although the fluid may not reaccumulate, it most frequently is resecreted, and after

a few months the scrotum will attain its former enlarged size. This tapping can be renewed from time to time, without inconvenience or danger. No treatment is necessary after this puncture, the patient usually attending to his ordinary duties, without laying up an hour. The use of a suspensory bag is the only element of treatment necessary. Where the patient desires security from the recurrence of the accumulation, he can obtain it by the injecting of the tincture of iodine into the sac, which so inflames the lining surface of the sac as to cause its two opposing surfaces to adhere to each other, and by thus obliterating the cavity prevent any further secretion. In some instances, although this adhesion does not occur, the lining surface has its functions so modified that it ceases to secrete this excess of fluid. A long list of irritating substances have, from time to time, been used as an injection. The profession at large have now adopted the tincture of iodine, as it gives the largest number of cures, accompanied with the smallest number of accidents. After the fluid has been drawn off, one drachm of tincture of iodine, diluted with two drachms of water, is injected through the canula into the sac, and is left in, the instrument being withdrawn. After the injection pain is soon experienced, of a very sickening and painful character, extending in the direction of the cord to the origin of the spermatic nerves in the spine, which may increase to such intensity as to require the free use of morphine. Inflammation attacks the lining membrane of the sac, extending to the skin of the scrotum—the tumor becoming, in forty-eight hours, red, hot, swollen, and painful. As the sac rapidly redistends with fluid, it is the practice of many surgeons to puncture at the end of the third or fourth day, and draw off the accumulation, when the inflammation, under the cold water treatment, subsides, and the scrotum in time nearly resumes its healthy dimensions. As the inflammation in the tunica vaginalis has thickened both the testicular and scrotal membranes, there remains for a long time apparently a slight enlargement of the testicles. If the fluid be not drawn off, absorption gradually reduces the tumor, and the final result is equally satisfactory, although the cure is more protracted. After the disappearance of the more acute inflammatory symptoms, painting the scrotum with the tincture of iodine will hasten the absorption of the fluid.

VARICOCELE.

Varicocele is an affection very frequently encountered by a military surgeon, and one for which too many efficient men are put upon light duty, or discharged from the army. It consists of a relaxation and en-

largement of the spermatic veins, a varicose condition in which the vessels become much enlarged and tortuous. The left spermatic veins are far more frequently affected than the right, which is accounted for by fecal accumulations in the sygmoid flexure of the colon compressing the vessels, and preventing the ready return of blood from them; and also to the absence of a valvular formation at the extremity of the left spermatic vein, where it empties into the vena cava, and which permits regurgitation of blood. The rarity of varicocele upon the right side is accounted for by the presence of this valve at the termination of the vein.

Varicocele is recognized by an enlargement of the spermatic cord, extending to the scrotum, and varying at times in size. When in the recumbent posture, and at rest, the swelling nearly disappears. In this respect it similates hernia. If pressure be made upon the upper part of the cord, and the patient resume the erect position, the veins accumulate blood, which the pressure prevents from returning into the circulation, and the tumor reappears. In this respect it differs from hernia, which could not reappear as long as the pressure is continued, as the finger prevents the bowel from protruding through the abdominal opening. When the cord is felt, the sensation of a large number of soft vessels is transmitted, resembling earth worms—plate 22, fig. 6. The tortuous condition of the veins is often easily recognized on the surface of the scrotum. Under exercise the swelling enlarges, accompanied by a sensation of weight, and often of acute pain of a neuralgic character, extending to the groin and loins. This pain is often so severe as to prevent the patient from walking or riding, and therefore attending to active service.

The treatment of varicocele will depend upon its extent. In mild cases, supporting the testicle in a suspensory bag, and thus relieving all traction upon the cord, is found a sufficiently palliative remedy. In cases where the vessels are tortuous, and in which the suspensory bag does not remove the symptoms to such an extent as to permit the patient to attend to his daily duties, an operation is called for, which has for its object the obliteration of the enlarged veins by ligation. Plate 22 gives three methods for effecting this result. In fig. 2 an incision is made from one and a half to two inches in length, parallel with and directly over the spermatic cord, carefully dividing upon a grooved director each layer of cellular tissue until the elements of the cord are clearly exposed. By feeling the mass of enlarged vessels, one will be felt much harder than the rest. This is the vas deferens, or excretory duct of the testicle, and is the only element of the cord which must be omitted in tying the vessels. This hard tube being carefully avoided (plate 22, fig. 2), all of the remaining vessels are surrounded by a ligature, which, in time, will cause their obliteration. As the sper-

matic nerves are always included in the noose of the ligature, the pain of the operation is very severe.

The vessels can be as readily secured without an incision by passing a pin behind them, and twisting a ligature in figure of 8 over the ends of the pin. The cord being seized between the thumb and index finger, its elements are felt, and the hard cord or vas deferens, which is easily distinguished, is separated from the soft vessels and pushed backward. The remaining vessels are drawn as far forward as possible, stretching the skin over them, when a pin is thrust through the skin, from within outward, passing behind the mass, and its point reappears again through the skin upon the opposite side. A thread is then firmly twisted around the protruding extremities of the pin, which causes sufficient pressure upon the vessels to effect their permanent obliteration in six or eight days. Plate 22, fig. 6, shows the position of the pin behind the tortuous veins; and in fig. 7 is exhibited the appearance of the pin with thread firmly twisted in figure of 8 around the protruding extremities. The point of the pin should be cut off after the operation is completed, to avoid its pricking the surrounding soft parts. The pin is withdrawn at the end of the sixth or eighth day.

A second method for obliterating these vessels is by the use of a subcutaneous ligature, applied as shown in plate 22, fig's 3, 4, and 5. In fig. 4 is seen two doubled threads, with looped extremities, each double thread passing through the loop of the other. When they are firmly drawn, as in fig. 5, it is seen how they compress firmly the vessels. The mode of application is as follows: Both ends of a piece of strong flax or silk thread are passed through the eye of a needle, which leaves a loop at one extremity of the double thread. The cord being seized between the thumb and index finger of the surgeon, is drawn forward, the hard cord of vas deferens distinguished and pushed behind and away from the mass, which is drawn forward. The needle is then inserted behind the fingers, and drawn through upon the opposite side, so as to have in front of the thread all of the vessels of the cord except the vas deferens, which was pushed out of the way. Fig. 3 gives the position of the double ligature and loop. A second needle is now taken, with a similar ligature, and the skin of the scrotum over the cord alone drawn forward. The point of the needle is entered through the orifice from which the first one escaped, and passing superficially under the skin and over the vessels, escapes out of the first puncture, so that a loop remains on each side of the cord. The corresponding ends of the threads are passed through the loops (fig. 4), and the threads drawn upon as in fig. 5, when the loops at once bury themselves in the punctures and compress the vessels. When firmly drawn, they should be tied over the cords. A single ligature can be applied in the same way, and will give better results. First pass the needle, armed

with a single thread, behind the vessels, and, drawing the skin forward, pass it back through the same openings in front of the vessels, and tie as usual. The knot at once buries itself in the puncture, and disappears from view.

FISTULA IN ANO.

Fistula in ano is a very common affection, particularly in the cavalry arm of the service. It is caused by the formation of abscesses in the vicinity of the rectum, which, after discharging their purulent contents either into the rectum or externally upon the buttock or perinæum, refuse to heal. They become chronic, contracted, tortuous passages, called fistulæ, from which a muco-purulent discharge continues, much to the annoyance of the patient so afflicted. There are three forms in which this disease shows itself. Plate 23, fig's 1 and 2, indicate varieties of incomplete fistulæ. In fig. 1 the fistulous passage passes from a *cul de sac* and empties its secretion into the rectum, *r*, just above the internal sphincter, leaving no opening upon the outer surface through which the purulent contents of the fistula can be discharged externally. In this case pus would be discharged per anum during defecation. In fig. 2 is seen a much more common variety of incomplete fistula—*b*, the tortuous blind *cul de sac*, with its neck, *a*, ending externally upon the inner face of the buttock. The cavity having no communication with the rectum, the purulent discharge would not be thrown into this cavity, but would be poured out continually upon the external surface within the fold of the buttock. Fig. 3 represents also a common variety called a complete fistula in ano, inasmuch as the fistula, *b b*, has an inner connection with the rectum at *a*, and also an external orifice upon the buttock at *f*. The contents of this secreting passage can either be emptied into the bowel or be poured upon the outer surface of the anal region. Owing to the free communication between the cavity of the rectum and the external surface, small particles of fecal matter escape through the fistula, giving an offensive odor to the secretion. Gases also escape from the rectum by this passage. The opening into the rectum is usually found immediately above the sphincter muscle, from one to one and a half inches from the outer surface of the anus; rarely over this depth. When we hear of cases in which the passage of a probe extended for three and four inches alongside of the bowel it can be readily understood, for the previously existing abscess may have been a large one, and have dissected the tissues for a considerable distance; but when we hear of an opening in the bowel from three to four inches from the orifice, it means that the operator, in passing the probe, had missed the lower opening in the bowel just

above the sphincter, and passing upward had found the termination of the *cul de sac*. The surgeon, feeling the end of the probe upon his finger passed into the bowel, and separated from it only by a thin mucus membrane, had forced the probe through it, making a second and artificial opening from the extremity of the *cul de sac* into the rectum. These anal fistulæ, whether complete or otherwise, usually run up alongside of the bowel, leaving only the thickness of the mucus membrane separating the *cul de sac* from the rectal cavity.

In examining a patient suspected of having an anal fistula, the patient is laid on his side, as in plate 23, fig. 6. The buttock drawn aside by an assistant, or the buttock being drawn aside with the left hand of the surgeon, he exposes a small papule or conical elevation, resembling a granulation, in the centre of which will be found a small orifice. By pressure upon the buttock this orifice is discovered by the appearance of a drop of pus squeezed from the interior of the fistula. If the bulb of a silver probe is introduced into this orifice and very slight pressure used, it will find its own way through the fistula, and will usually take up a direction inward and upward toward the bowel. Should it be necessary the probe should be slightly bent, to enable it to follow more readily the irregularities of the passage. No force should be used in this examination, and when blood is drawn it indicates a needlessly rough and painful exploration. If the index finger be passed into the rectum above the sphincter muscle of the anus, the end of the probe can be readily felt separated from the finger by a thin mucus membrane, which gives the impression of the bulb being covered by a thin film. Often the probe will find its way through an opening in this attenuated mucus membrane, and pass into the bowel in contact with the finger, even when the *cul de sac* continues upward along the bowel for two or three inches.

These fistulæ show so little disposition to heal by the use of general or local applications, that no other treatment is worthy of consideration but an operation which has for its object the radical cure. Experience shows that the anatomy of the parts has much to do with the difficulty of closing up these secreting passages. The chief obstacle to healing is said to reside in the continued action of the sphincter muscle of the anus, which, by keeping the walls of the abscess in constant motion, draw the opposing sides away from each other and prevent union. Experience shows that unless the sphincter muscle is divided, a cure of rectal fistulæ is nearly impossible, and also that there is never a necessity for cutting the bowel above the sphincter muscle. When surgeons report cases in which an incision four inches deep was made through the bowel, it is an indication of bold and dangerous surgery from ignorance.

The mode of procedure in operating for fistula in ano is as follows:

The bowels having been well emptied by a purgative dose, the patient lying upon his side, as in plate 23, fig. 6, and under the influence of chloroform, a small silver grooved director, terminating in a probe, has its probe extremity entered into the fistula, and passing upward through the sinus toward the bowel, is felt by the index finger of the left hand passed into the anus. As soon as the finger feels that the probe reaches the mucus membrane of the rectum, immediately above the internal sphincter, and about one inch from the external surface of the anus, an effort is made to find a passage into the bowel. Should none be found, the surgeon turns the end of the probe against the thin mucus membrane just above the sphincter, and without hesitation forces a passage into the rectal cavity, thus rendering the sinus a complete fistula. The probe is now thrust forward and upward sufficiently to enable the bulb of the index finger to hook the end of the probe, as in fig. 4, and, drawing it downward and outward, draw its extremity through the rectum and anus until it rests upon the opposite buttock, both ends of the probe being visible, the grooved portion remaining in the fistula—fig. 5. The sphincter muscle, the enemy to the healing of the fistula, is now clearly on the outside of the probe. The blade of a sharp-pointed bistoury is now run through the groove in the director, and in cutting its way out cuts out the probe and divides completely the sphincter muscle. As soon as the probe is cut out blood wells up freely from the wound, as the hemorrhoidal arteries ramifying around the anus are divided in the incision. A sponge is thrust into the wound to dry the surface of the incision, while the surgeon saturates a piece of soft lint with the liquid persulphate of iron. Removing the sponge, the lint is thrust to the bottom of the wound, a compress applied, and secured by a T bandage. One band passes around the waist, the other passes between the buttocks, around the perinæum, with the anterior portion of the band slit so as to allow one strip to pass on each side of the scrotum and across each groin, to be secured to the abdominal band. Opium is freely given to allay pain and to keep the bowels quiet. When suppuration is established, which is usually at the end of the second or third day, the dressings are removed, which will expose a clean, granulating wound. A daily dressing of a little simple cerate upon a soft cloth, secured in place by the T bandage, is all the dressing required. Under this simple treatment the wound will granulate from the bottom and sides, and gradually becoming more superficial, will, in the course of two or three weeks, be completely cicatrized—a radical cure of the annoying fistula. The upper portion of the *cul de sac*, above the point where the probe was forced into the rectum, usually heals simultaneously with the rest of the sinus, and gives no trouble.

The ordinary method of dressing fistulæ after an operation, is the application of a tent of greased lint, which is forced up the rectum daily;

to a less depth as the bottom of the wound fills up with granulations, until the dressing becomes a superficial one. The object of this treatment is based upon the desire to prevent the wound healing by quick union. The incision being performed by a sharp instrument, leaves two nicely cut surfaces in apposition to each other, which would unite together in twenty-four hours, leaving the fistulous passage lined by its hard, secreting membrane, unobliterated. The consolidation of the sinus can only be secured by keeping the lips of the wound asunder, so as to force granulations to form along the lining membrane of the fistula, and thus force the wound to heal from the very bottom.

Although the daily application of the tent of lint, thrust between the lips of the wound, prevents any union, it is a very painful operation—even more so than the cutting—as it forces a large roll of lint against a very sensitive, inflamed surface: it is also a very troublesome application. The use of the persulphate of iron, either upon a camel's hair brush or a soft piece of lint, is in every way a preferable remedy. When the entire surface of the wound is carefully swabbed with this strong fluid, its immediate action is to form a hard, crusted clot of blood over the surface, which checks the bleeding, and placing a foreign body between every portion of the opposing surfaces precludes the possibility of adhesion by the first intention. Again, the application of the persulphate or perchloride of iron acts as a caustic, producing a superficial slough from the entire surface of the wound, including the pyogenic membrane with which the fistula was lined, which, in itself, would prevent any quick union. It, moreover, stimulates the surface in such a way as to cause the rapid formation of granulations; and then has the very decided advantage over all other applications that no further dressing is required.

Surgeons who use the greased lint tent lay great stress upon the daily dressing, as a very important element in the successful treatment. With the thorough application of the persulphate of iron I have no further fear for the patient, nor even is it necessary for the surgeon to see him again. Should he have come from a distance to be operated upon, he can return to his friends the same day, a few hours after the operation has been performed, the surgeon giving the assurance, which experience with this remedy will permit him to do, that the case will now cure itself without further treatment. I have used this remedy for ten years, in every instance with success. It is a perfect method, which leaves nothing to be desired. The case is a very rare one which requires the patient to keep his room more than twenty-four hours.

The use of opium is kept up for four or five days, when the bowels are emptied by a dose of castor oil, citrate of magnesia, or any simple medicine, mild in its action, which will produce fluid evacuations; after which the case is left to nature. Although the sphincter is or *should be* divided

completely in every case, no fear should be felt that the muscle will not unite again, and control over the contents of the bowel be resumed. It may be, however, one or two weeks before the patient will have the perfect control of the sphincter muscle, but it will assuredly be regained in every case in which the operation has been properly performed, as directed above, and where the bowel has not been ignorantly divided to too great a depth.

A ligature passed through the fistula and bowel, with the intention of cutting slowly and very painfully through the same structures which the knife divides, is a remedy extensively used by itinerant specialists, who take advantage of the suffering community by depicting the horrors of the knife to nervous, timid patients, and extolling the certain success of a simple thread. This application will, at times, cure fistula in ano, but always at the expense of much suffering. The *écraseur*, or more rapid ligature, is troublesome of application, and possesses no advantage.

Plate 1.

Fig. 1.—A Confederate army litter for transporting wounded men To secure the heavy duck-cloth or sacking to the frame, a groove three-quarters of an inch wide and five-eighths of an inch deep is cut out in the length of the frame. The cloth is tacked in this, and secured by a lath which fits accurately the groove, and which is nailed in, covering the cloth. The tension upon the cloth is not borne by the tacks, but is uniformly supported by the entire lath, and therefore never rips off.

Fig. 2.—A Confederate four-wheeled field ambulance wagon. In the Confederate army there are two kinds of ambulance wagons—one with two wheels, and the one represented in the figure. The four-wheeled is the most convenient, and is the one in general use.

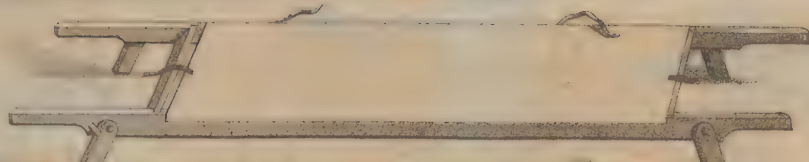
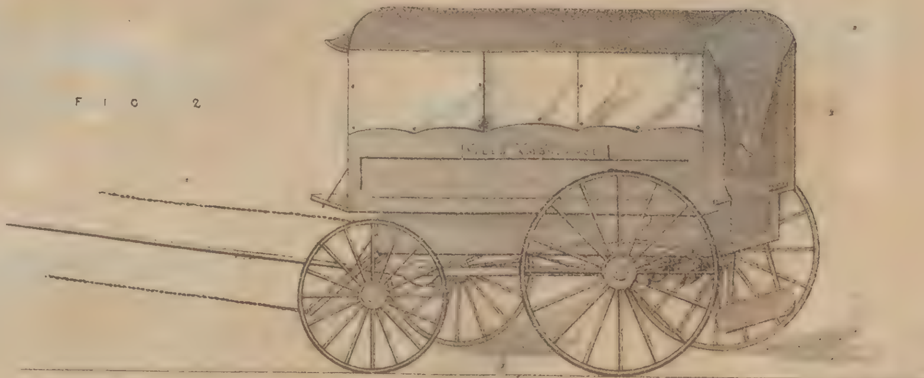


FIG 1.

FIG 2



P. 2

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Plate 2.

Fig. 1.—Vertical section of a finger, showing the relations of the phalangeal bones with the soft parts; also the relations which the articular surfaces bear to the natural folds on the palmar surface of the finger.

Fig. 2.—A finger flexed to show that the articulating surfaces are not to be found at the apices of the angles which the bent finger makes.

Fig. 3.—Amputation of a finger in second phalangeal joint. The position of the finger while the knife enters between the articulating surfaces on the back of the finger.

Fig. 4 shows the horizontal position of the knife after having traversed the joint from behind.

Fig. 5.—Flap operation—shows the knife transfixing the finger at the second digital fold, so as to make the palmar flap. *a b c* marks the form and size of the flap, or the line in which the knife will cut from within outward.

Fig. 6.—Continuation of the same amputation. Flap turned back—the knife placed perpendicularly, dividing the anterior and lateral ligaments, and passing into the joint.

Fig. 7 exhibits two methods of amputating an entire finger. *a d c b* shows the flap after the oval method, the palmar incision following the palmar fold at the web of the finger; *a c b* the method by two lateral flaps, the incision cutting across the palmar digital fold, and passing up obliquely in the palm nearly to the transverse fold.

Fig. 8.—The hand, with relation of bones and joints to the soft parts. *a b c*, showing the extent and direction of incisions in amputating the thumb, with its metacarpal bone, at its articulation with the trapezium.

Fig. 9 shows the position of the thumb, and also how the knife is held while the point of the blade divides the ligaments, and opens freely the joint.

Fig. 10.—The appearance of the wound and hand after removal of the thumb.

Plate 3.

Fig. 1 represents the line of incision for amputating the little finger with metacarpal bone. A similar line, traced upon the back of the hand, defines the extent of the flap.

Fig. 2.—Position in which the hand is held in amputation of the fingers. *a b c* shows the line of incision for opening the metacarpo-phalangeal joints; after traversing which, the direction of the knife is changed, as in the figure, so as to make a flap from the palmar surface.

Fig. 3.—*a b c* marks out the extent of the flap, and shows the relation of the heads of the metacarpal bones to the soft parts.

Fig. 4.—Anatomy of the hand. *a*, carpal extremity of ulna; *b*, extremity of radius; *c*, semilunar bone; *d*, scaphoid; *e*, cuneiform; *f*, unciform; *g*, os magnum; *h*, trapezoid; *i*, trapezium; 1, 2, 3, 4, 5, heads of metacarpal bones of the thumb and fingers.

Fig. 5.—Amputation of the four fingers, with their metacarpal bones. *a b*, showing the carpo-metacarpal articulation between the trapezoid, os magnum, and unciform for the carpus, and the four metacarpal bones of the fingers; *b c*, the line of incision extending through the muscular septum, between the thumb and index finger.

Fig. 6.—The completion of the amputation. *a b c*, showing the extent of the flap from the palmar surface; *c*, on a level with the unciform bone, and *a*, near the root of the thumb, indicating the two points through which the palm is transfixed in cutting out the flap, *a b c*.

Fig. 7 indicates position of hand and line of incision in amputation at the wrist-joint, with palmar flap.

Fig. 8 shows the flexed position of the hand, and also the position of the knife while opening the radio-carpal articulation from the back of the wrist, and completing the operation commenced in fig. 7.

P 3


A
B
C
a
b

Plate 4.

Fig. 1.—Delineations of the prominences upon the heads of the bones forming the elbow-joint. *A*, humerus; *B*, radius; *C*, ulna.

Fig. 2.—Lateral view of the elbow-joint. *A*, humerus, with internal condyle and epitrochlœa; *B*, head of radius concealed by *C*, the head of ulna, with olecranon and coranoid processes—showing the curved line marking out the articulating surfaces of humerus and ulna.

Fig. 3.—Anterior view of the elbow-joint. *A*, humerus; *B*, radius; *C*, ulna, with line of articulating surfaces between the three bones.

Fig. 4.—The outlines of the bones of the arm and forearm. *a c*, the points at which the knife transfixes the forearm, and *a b c*, the outline of the anterior flap for covering the head of the humerus in amputation at the elbow-joint.

Fig. 5.—*A B C*, the flap delineated fig. 4, turned up, so as to expose the line of articulation as seen in fig. 3, and the position of the knife as it completes the section of the skin on the back of the elbow-joint.

Fig. 6.—Circular amputation at the elbow-joint. *a a*, flap of skin dissected up and turned over upon the arm as the cuff to a coat-sleeve. The edge of the knife, placed behind the arm and looking toward the operator, completing the section of the retentive ligaments.

Fig. 7.—The appearance of the stump after the amputation. *B*, the head of the humerus, covered with cartilage, with remains of the fibrous capsule. *a*, the position of the brachial artery in front of the bone.

Plate 5.

Fig. 2.—Circular amputation of the forearm, the position of the arm to be operated upon, and also the position of the hands of the operator. The first black line above the wrist indicates the line of circular incision through the skin; *b*, flap separated from the cellular tissue, and turned up, cuff-like. The second line marks the root of the fold of skin, turned up, and is the line of section for all the muscles down to the bone. The distance between the second and third line indicates the width of the turned-up flap.

Fig. 1 shows the retractor, a piece of cloth thrust between the bones, and drawn backward, to protect the soft parts of the stump from being injured by the saw.

Fig. 3.—Flap amputation of the forearm. *c e d* shows the anterior flap cut up by transfixion, and exposing at *b a* the radial and ulna arteries in the anterior flap; *c d* shows the points at which the knife is again thrust through the arm behind the bones, so as to complete the severing of the muscles by making a posterior flap.

Fig. 4.—The appearance of the stump after amputation of the forearm by anterior and posterior flaps; *c*, cut end of radius; *d*, of ulna; *a*, position of the ulna artery; *b*, radial artery.

Fig. 5.—Circular amputation of arm. *a*, the first circle made through the skin; *b*, second incision made through the muscles to permit of free retraction; *c*, third line of incision to the bone, dividing all soft parts.

Fig. 6.—Appearance of the stump after circular amputation of the arm. 1, Biceps muscle; 2, humerus; *a*, brachial vessels on inner side of stump; *b*, superior profunda branch of brachial artery.

Fig. 7.—Outline of stump after amputation by internal and external flaps, showing position of the bone at angle of flaps.


FIG. 5
FIG. 6
FIG. 7
FIG. 1
FIG. 3
FIG. 2
FIG. 4

p. 6

FIG. 1. FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6.

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Plate 6.

Fig. 1 represents the scapulo-humeral joint; *b*, clavicle attached to *c*, the accromial process of *d*, the scapula; *e*, the head of the humerus secured to the glenoid cavity by the capsular ligament.

Fig. 2 shows the position of the glenoid cavity, *a*, in relation to the coracoid process, *c*, and accromial process, *b*.

Fig. 3 shows the position of the bones of the shoulder in relation to the soft parts, and also the position in which the limb is held by the surgeon while he commences an amputation at the shoulder-joint by external and internal lateral flaps—Lisfranc's method. The point of the knife enters the arm from behind at *c*, corresponding to the posterior of the axillary space or border of the latissimus dorsi muscle, passes obliquely upward, grazing the head of the humerus, and appears at *a*, which corresponds to an interspace between the coranoid and accromial processes of the scapula. The line *a b c* marks the extent and direction of the flap.

Fig. 4.—Cutting the internal flap in Lisfranc's amputation. *a b c*, external flap raised; *d*, head of the humerus freed from the glenoid cavity, with capsule divided. The knife has passed through the joint to the inner side of the humerus, and is now cutting out the inner flap.

Fig. 5.—Larrey's method of disarticulating at the shoulder-joint. *a c b*, a short perpendicular incision upon the head of the humerus; *c d* and *c e*, two lateral incisions passing obliquely downward, and dividing all the muscles, isolating the joint.

Fig. 6.—*a b c d* shows the outline of the incision when the arm has been removed by the oval, or Larrey's method; *e*, the glenoid cavity, with remnants of capsular ligament; *c*, axillary or brachial vessels. The completion of the operation of fig. 5 is seen to be a circular incision passing around the axillary portion of the arm on a level with the inferior boundary of the axillary space.

PLATE 7.

Fig. 1.—Bones of the foot. *a*, inferior extremity of tibia; *b*, inferior extremity of fibula; *c*, articulating face of astragalus: *d*, external prominence of os calcis; *e*, scaphoid; *f*, cuboid; *g*, internal cuneiform; *h*, middle cuneiform; *i*, external cuneiform; 1, 2, 3, 4, 5, the metatarsal bones, with formation of tarso-metatarsal articulation. Upon this figure the direction of all the articulating surfaces can be studied.

Fig. 2.—Lateral outline of the bones, with relation to the soft parts. *a d c b* traces the line necessary in amputating the big toe, with its metatarsal bone.

Fig. 3.—A foot, showing the appearance of the flap, *a b c d*, after an oval amputation of the big toe; *e*, head of metatarsal bone; *f h g* represent an amputation, with two lateral flaps.

Fig. 4.—The relation of the bones of the foot with the soft parts, with transverse lines marking the various dorsal incisions necessary in performing all disarticulations of the foot. *a a*, the line of dorsal incision required in amputating the toes; *b b*, incision in the tarso-metatarsal amputation, or Lisfranc's; *c c*, line of the medio-tarsal, or Chopart's amputation; *d d*, the dorsal incision for Syme's or Pirogoff's amputation, viz: tibio-tarsal amputation.

Fig. 5.—*a b c*, amputation of all the toes. The knife has passed through the joints and behind the phalangeal bones to complete the flap from the sole of the foot.

Fig. 6.—Lisfranc's amputation. Dorsal flap dissected up, exposing the line of articulations. *a*, the head of the second metatarsal bone, boxed in between the external and internal cuneiform. The figure represents the mode of dividing the lateral ligaments; *a b c*, the curve which the knife makes.

Fig. 7.—All the tarso-metatarsal joints opened, and blade of knife passed behind metatarsal bones to make the posterior flap.

Fig. 8.—The completion of the plantar flap in Lisfranc's amputation. *f*, the anterior portion of the foot drawn upward; *b*, the plantar flap; *d*, the mode of holding the knife in rounding off the end of the flap.

Fig. 9.—Chopart's amputation, or the medio-tarsal, showing how the foot is grasped in the left hand of the surgeon, and depressed while the knife opens the joint formed by the astragalus and os calcis posteriorly, and the scaphoid and cuboid anteriorly; *a*, dorsal vessels of the foot.

Fig. 10.—Chopart's amputation completed. *a d*, dorsal vessels: *c*, plantar vessels, on under and inner side of flap: *a b c d*, size and form of flap from sole of foot.

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Plate 8.

Fig. 1.—Lateral sketch of foot, with relative position of the bones. The lines traced across the foot showing the direction of the plantar incisions for performing the various disarticulations upon this extremity. This figure should be studied in connection with plate 7, fig. 4. *a a a a*, the line of the tarso-metatarsal incision in Lisfranc's operation; *b b b b*, the incisions for effecting the medio-tarsal or Chopart's amputation; *c c c*, the incisions for the tibio-tarsal or Syme's amputation at the ankle-joint. If the incision, *c c*, from the end of the tibia to the plantar surface of the heel. ran a little more obliquely backwards, it would trace out the incision for Pirogoff's amputation at the ankle-joint.

Fig. 2.—Syme's tibio-tarsal disarticulation. The completion of the operation by separating the tendo achillis from the os calcis.

Fig. 3.—Completion of Pirogoff's amputation. The inferior extremities of the tibia and fibula removed, exhibiting the general outline of the plantar flap, with a portion of the os calcis embedded in its centre.

Fig. 4.—The appearance of the stump after Pirogoff's amputation.

Fig. 5.—Amputation of the leg in lower third. *a b*, the extremities of the flap formed by a union of the vertical incision with the circular; *d*, position of posterior vessel; *e*, peroneal artery; *f*, anterior tibial vessels. Lenoir's method.

Fig. 6.—Circular amputation at the seat of election, the upper third. *a b c*, the line of incision through the skin for circular flap; *d*, circular flap of skin turned up like cuff of sleeve, being from two and a half to three inches in length—the knife dividing the muscles to the bone at the base of the flap.

Fig. 7.—*a a*, retractor of cloth placed between the bones to protect the stump; the position of the saw.

Fig. 8.—Appearance of stump before closed. *h*, tibia; *g*, fibula; *b*, anterior tibial artery and veins in front of interosseous ligament and between the bones; *c*, posterior tibial vessels behind the tibia; *d*, peroneal artery and two veins behind the fibula; *f*, sural vessels for calf muscles.

Plate 9.

Fig. 1.—Amputation of leg in upper third by posterior flap. *a b c*, line in which the flap will be cut by the knife transfixing the calf at *a c*—the hand of the surgeon drawing back the muscles. The objection to this operation is the size and weight of the posterior flap. After section of the bones and removal of the limb, a more useful and lighter flap is made by holding the flap upon the palm of the hand, and slicing off a thick layer of muscle from its anterior face.

Fig. 2 gives the anterior transverse lines for tracing incisions in amputations about the knee-joint. *n*, fibula; *m*, tibia; *p*, patella; *o*, femur; *g h k*, circular amputation of leg; *d e f*, anterior line of incision, where the amputation is performed with a large posterior flap, as in fig. 1; *a b c*, anterior incision for disarticulation at knee-joint, as seen in fig. 4.

Fig. 3.—Anatomy of knee-joint. *a*, inferior extremity of femur; *b*, head of tibia; *c*, patella enveloped in the anterior ligament or tendon of the quadruceps extensor muscle, called ligamentum patellæ; *d*, crucial ligaments; *e*, popliteal artery, lying immediately upon and behind the joint.

Fig. 4.—Amputation at knee-joint by posterior flap. The operation commenced by a circular incision into the joint just below the patella, which extends through half the circumference of the knee. *a b c*, form and extent of flap; *p*, patella; *f*, femur; *d t g*, line of incisions in performing the posterior flap amputation of the leg in upper third or seat of election.

Fig. 5.—Amputation at knee-joint by anterior flap. *a b c*, line of anterior flap; *t*, anterior surface of tibia exposed; *p*, patella; *f*, femur; *d*, anterior flap turned up. The knife is passing through the joint between the heads of the bones.

FIG. 1

FIG. 2

FIG. 3

FIG. 4.

FIG. 5.

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FIG. 1
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FIG. 5
FIG. 6
FIG. 7

Plate 10.

Fig. 1.—Anterior and posterior flap amputation of the thigh in middle third. *c f*, line of anterior flap; *b*, anterior flap held up by hand of an assistant. In perforating for the anterior flap the operator, with his left hand, draws the soft parts on the anterior surface of the leg as much forward as possible, so that the anterior flap will comprise half of the circumference of the thigh. The knife has been again thrust through the thigh and behind the femur, so as to cut out the posterior flap, *d*.

Fig. 2.—Appearance of stump after double flap amputation. *e*, anterior flap; *f*, posterior flap, separated to show the extremity of the femur deeply embedded in the muscles; *g*, femoral artery and vein on inner side of flap.

Fig. 3.—Circular amputation at middle of thigh. *c*, first incision through the skin; *d*, incision through the muscles; *e*, final incision to the bone; *f*, section of the femur; *a a*, retractor around the bone to protect the upper flap, *b*.

Fig. 4.—Appearance of stump after circular amputation. *a*, femur; *b*, femoral artery and vein; *c*, muscular vessels.

Fig. 5.—Amputation at hip-joint. Anatomy of the parts. *c*, point of entrance of knife above great trochanter; *a*, exit of the point near inner fold of the groin, the blade in its passage over the anterior surface of the hip-joint and head of the femur having divided freely the capsule of the articulation; *a b c*, size and form of anterior flap.

Fig. 6.—Amputation at hip-joint. *a*, hand of assistant lifting the anterior flap; *c c*, femoral artery and profunda branch; *b*, head of femur turned out of the cotyloid cavity, the knife behind the femur cutting out posterior flap.

Fig. 7.—Double flap amputation at hip-joint completed. Size, form, and direction of flaps. *f f*, the femoral artery and the profunda branch.

Plate 11.

Fig. 1.—Resection of the lower jaw. The incision for removing half of the bone from its symphysis to the glenoid cavity, runs along the base of the jaw. *a b c*, the flap dissected up and held over the temple by an assistant; *d*, the symphysis of the lower jaw, where the bone has been divided by the saw; *e*, the lower jaw forcibly drawn outwards so as to expose for section the pterygoid and temporal muscles, and render disarticulation of the jaw easy.

Fig. 2.—Removal of the anterior portion of the jaw, including the symphysis. *d*, the incision passed through the middle of the lower lip in the median line, extending under the chin to the hyoid bone; *a b*, the ends of the flaps dissected up and drawn aside. The saw is applied to the lower jaw at the canine fossa.

Fig. 3.—Removal of upper maxillary. The line of incision through the cheek is seen in fig. 4. The flap is dissected up from the bone, and the nasal cartilages separated from the nasal process of the maxilla; the bone is readily isolated from its intimate attachment by passing one blade of a strong Liston's forceps through the mouth, the other through the anterior nares, thereby dividing the roof of the mouth or palate process of the superior maxillary bone. One blade of the forceps can again be placed in the upper part of the nares; the other in the orbit to divide the floor of the orbit. The malar connection can be divided with the saw or by the bone forceps, by placing one blade in the orbit, the other in the temporal fossa.

Fig. 4 shows the curved line of incision from the zygomatic arch to the angle of the mouth; also, how the wound is dressed by several points of interrupted suture, and how little deformity results from this resection.

FIG. 1

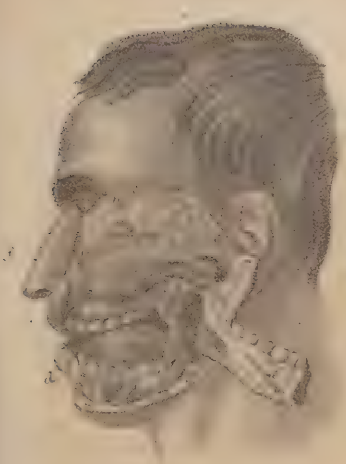

FIG. 2

FIG. 3

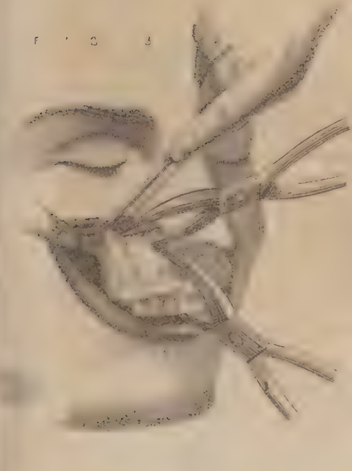

FIG. 4

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FIG 1
d
h
s
FIG 2
f
c
a
b
d
d
e
FIG. 4
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2
FIG 5
4
3
1
2
1
3
4
2
FIG. 3
4
1
3
FIG 6

Plate 12.

Fig. 1.—Resection of the shoulder by a deltoid flap. *d*, the flap made from the deltoid muscle turned up upon the shoulder; *h*, head of humerus isolated from the glenoid cavity; *f*, chain-saw passed behind the head of the bone in the act of resecting.

Fig. 2.—Resection of the shoulder by the straight incision. *f*, position of the clavicle; *c*, accromial process of the scapula; a perpendicular incision of five inches in length passing down to the bone, commencing at the accromial process; *d d*, two retractors or hooks for drawing aside the soft parts, exposing clearly, *a*, the head of the humerus; *f*, resection of the sternal end of the clavicle, the soft parts divided by an incision upon and parallel with the clavicle—the soft parts retracted to expose the bone.

Fig. 3.—Resection of the elbow-joint. 1, 2, 3, 4, of fig. 4, marks out extent and direction of the incisions; 1, hand of assistant raising the posterior flap; 2, joint exposed; 3, saw applied to, 4, the inferior extremity of the humerus.

Fig. 4.—The H incision, generally used in exposing the elbow-joint for resection of the heads of the bones. The method of closing the same by suture when the section of the bones is completed.

Fig. 5.—Resection at the wrist-joint, removing the styloid process of the ulna. 1, the flap; 2, carpal extremity of the ulna; 3, the blade of a spatula placed under the bone to be divided, so that the saw, 4, cutting against this, can not injure the soft parts.

Fig. 6.—A hand, with delineations of the bones of the forearm and carpus. 1, 2, 3, 4, form and extent of an incision which will expose the posterior surface of the radio-carpal joint, and facilitate the removal of the carpal extremity of both radius and ulna.

Plate 13.

Fig. 1.—Resection of the hip-joint; a straight incision, six inches in length, on the outer side of the joint, upon and parallel with the femur, commencing about two inches above the great trochanter, or on a level with the anterior superior spinous process of the ilium. The soft parts drawn aside to expose—*a*, the femur; *b*, the great trochanter; *d*, the head of the femur.

Fig. 2.—Resection of the hip-joint by means of an external flap, cut from below upwards, by transfixion. 1, the head of the femur dislodged from the acetabulum and turned outward, so that a guard can be placed behind the head for the protection of the soft parts from the saw; 3, a chain-saw, placed around the neck of the femur for its resection.

Fig. 3.—Resection of the knee-joint. The articulation exposed by making two elliptical incisions from one condyle to the other, including the patella, which is removed. 1, a retractor or piece of cloth passed around the inferior extremity of the femur to retract the soft parts; 2, a guard placed behind the bone to protect them from the saw; 3, the extremity of the femur being removed by, 4, the saw. The two round dark surfaces, surrounded by white rings, are the articulating cups upon the head of the tibia.

Fig. 4.—Resection of the ankle-joint. The extremity of the bone is exposed by an L incision, made parallel with the outer border of the bone, and then at right angles across its head; 2, a chisel, and 3, mallet, which are the instruments used for dividing the bone. When the section of the bone is effected, a knife divides the ligaments and completes the isolation.

FIG. 1

FIG. 3

FIG. 2

FIG. 4

FIG. 2

FIG. 3

FIG. 1

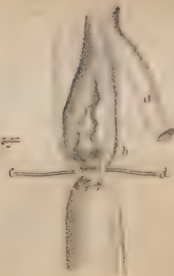


FIG. 4

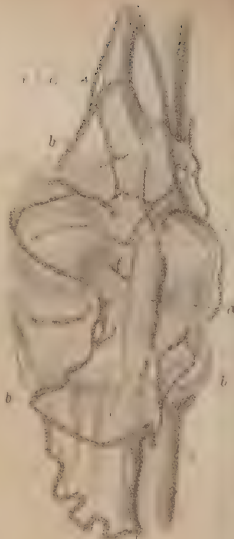


FIG. 5

FIG. 6

FIG. 7

FIG. 8

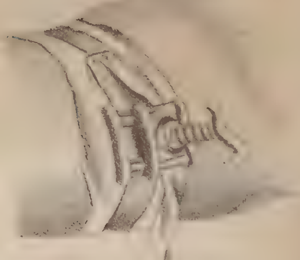


Plate 14.

Fig. 1.—Structure of arteries. *a*, external or cellular coat, the tough, resisting coat of arteries dissected up; *b*, thick elastic muscular or middle coat, also dissected from *c*, the inner or serous coat. Both the coats, *B* and *C*, are divided by the thread in the application of the ligature.

Fig. 2.—The appearance of an artery after the application of a ligature. *c d*, a ligature applied so as to cut through the inner and middle, which are the brittle coats of the artery. These coats are seen puckered in, have become united, and are continuous on each side of the vessel; *b*, clot of blood formed in the upper portion of the vessel; no clot is seen below the ligature; *a*, the first collateral branch, which leads the blood through a circuitous route, and will take the place of the main channel obliterated by the ligature.

Fig. 3.—An artery obliterated by a ligature. *c*, a fibrous band formed in the former site of the ligature; *b b*, fibrinous clots in ends of the artery for the permanent occlusion of the vessel.

Fig. 4.—Occlusion of the popliteal artery, *a*, showing how the branches, *b b b*, given off both above and below the obliterated portion, enlarge and communicate, so as to carry on the collateral circulation, and restore it to the natural channel below the obstruction. Also explains how the collateral circulation, bringing blood to the lower portion of a divided artery, induces secondary hemorrhage.

Fig. 5.—Mode of securing an artery after amputations, by using a tenaculum. c, loop of ligature upon the instrument ready to be applied to the vessel.

Fig 6 shows how the femoral artery should be compressed by the thumbs of an assistant in amputations of the inferior extremity. The limb is grasped by both hands, and one thumb placed upon the other. Pressure is only made by one thumb at a time; when the lower one becomes fatigued, pressure is made by the upper upon the lower; in this way they relieve each other.

Fig. 7.—The use of the simplest form of field tourniquet, composed of a bandage or folded handkerchief with a knot in it. The knot is placed over the course of the femoral artery, and the bandage tightened by twisting it with a piece of stick.

Fig. 8.—The mode of applying the screw tourniquet.

PLATE 15.

Fig. 1.—Anatomy of the hand, showing the course and relations of the termination of the radial artery. 1, band of annular fascia, which binds down the tendons at the wrist; 2, extensor ossis metacarpi pollicis; 3, extensor primi internodii pollicis; 4, extensor secundi internodii pollicis muscle; *a*, radial artery in the depression between the tendons upon the back of the thumb.

Fig. 2.—The incision, an inch long, made in a line parallel with the index finger, and necessary for exposing the radial artery on the back of the hand. *a*, the artery; *b*, the ligature passed behind it.

Fig. 3.—Anatomy of the forearm and hand, showing the course and relations of the radial and ulna vessels. *a*, brachial artery, accompanied by *b*, median nerve; *c*, median basilic vein at the bend of the elbow, used in phlebotomy; *d*, aponeurotic expansion of the tendon of the biceps muscle, under which passes the brachial artery, and over which lies the median basilic vein. As this vein is separated from the brachial artery at the bend of the elbow only by the aponeurotic expansion of the biceps tendon, the artery may be readily injured by bleeding carelessly in this vein. Under this tendon the brachial artery bifurcates into radial and ulna. *g*, *k*, curved course of the ulna artery, accompanied by two veins, and *h*, the ulna nerve; *l*, the continuation of the ulna artery under the annular ligament, to form the superficial palmar arch, with branches passing to each finger; *i*, tendon of the flexor carpi ulnaris muscle upon its outer side; *j*, the tendon of the flexor sublimis digitorum upon the inner side of the vessel, the artery always lying between these two muscles, being more or less covered by the flexor carpi ulnares; *p t*, radial artery, running a straight course, and accompanied by *r s*, two veins; *q*, tendon of the supinator longus muscle upon its outer side; on its inner side is the flexor carpi radialis muscle. Either of these tendons are used as a guide for finding the artery.

Fig. 4.—Tracing of the brachial artery with its branches, the radial and ulna, through the arm, forearm, and hand, with size and direction of the incisions required in ligating these arteries in the lower and upper part of the forearm. *a*, skin; *b*, cellular tissue; *c*, ulna nerve; *d*, accompanying vein; *a*, ulna artery elevated upon the aneurism needle.

FIG. 3.

FIG. 4.

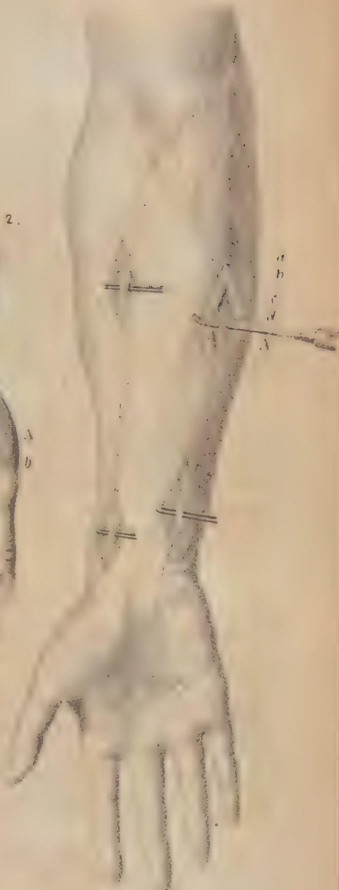
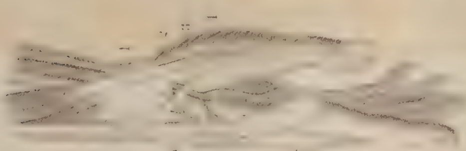


FIG. 2.

FIG. 1.



& Cogswell, Columbia. 5

Plate 16.

Fig. 1.—Position and relations of the brachial vessels in the arm. *A*, brachial artery as it appears from the axilla to the elbow; *F*, the large brachial vein which accompanies it; *B*, the basilic vein, also accompanying the artery; *E*, the median nerve lying above upon the outer side of the artery, crossing its course in the middle of the arm, to run upon its inner side, near the elbow; *H*, inferior profunda branch of the humeral artery, accompanied by *K*, the ulna nerve; *C*, coraco-brachialis muscle; *D*, biceps muscle, the package containing the brachial vessels and nerves always found on the inner border of this muscle; *a*, aponuerotic fascia from the tendon of this muscle, forming a bridge at the elbow under which the brachial artery passes.

Fig. 2.—The direction of the brachial artery traced upon the inner side of the biceps muscle, with the incision for its ligation, both in upper and lower portion of the arm. *a*, the artery elevated upon *c*, the grooved director; *b*, the sheath of the vessel.

Fig. 3.—Exposure of the axillary space. 1, the pectoralis muscle, forming the anterior boundary of the space; 3, the latissimus dorsi muscle, forming the posterior wall; 4, biceps and coraco-brachialis muscles on the outer side of the arm; 5, the origin of the triceps muscle; 6, superficial fascia which covers and binds down all of the structures of arm; *k*, the axillary artery, appearing between the median nerve, *d*, and *f*, the ulna nerve; *i*, scapula branches of the axillary artery; *g*, axillary vein; *e*, the internal cutaneous nerve.

Fig. 4.—The position of the incision for securing the axillary artery, being in a line with the inner border of the coraco-brachialis and biceps muscles, and corresponding to the junction of the anterior and middle thirds of the axillary space. *b*, the axillary artery upon the grooved director; *d*, axillary vein; *a*, median nerve; *c*, ulna nerve.

Plate 17.

Fig. 1.—Anatomy of the dorsum of the foot, with course of the dorsalis pedis artery, the continuation of the anterior tibial artery. *A*, dorsalis pedis artery accompanied by its vein bound down by 1, the annular ligament, having, 2, the tendon of the extensor pollicis pedis on its inner side, and 4, 3, the extensor communis digitorum upon its outer side.

Fig. 2.—Incision upon the ankle for securing the dorsalis pedis artery in a line drawn from midway between the malleoli to the space between big toe and second toe.

Fig. 3.—Relations of the anterior and posterior tibial arteries. 4, tibialis anticus muscle, hooked forward; 5, flexor communis digitorum, drawn outward; *A*, anterior tibial artery, with *B*, accompanying vein, lying deeply upon the interosseous membrane between these muscles; 8, the extensor pollicis pedis assuming the same position on the outer side of the inferior half of the anterior tibial artery as the flexor communis did in the upper half of the leg: *c*, anterior tibial nerve on the outer side of the artery; 9, posterior tibial artery drawn out from beneath the gastrocnemius and soleus muscles.

Fig. 4.—1, 2, incisions made in a line drawn from midway between the head of tibia and fibula above, to a point on the back of the foot between the malleoli; *A*, the artery hooked up; 3, incision made upon the inner border of the muscles of the calf, for securing the posterior tibial artery; *A*, the artery; *b*, the posterior tibial nerve.

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FIG. 1.

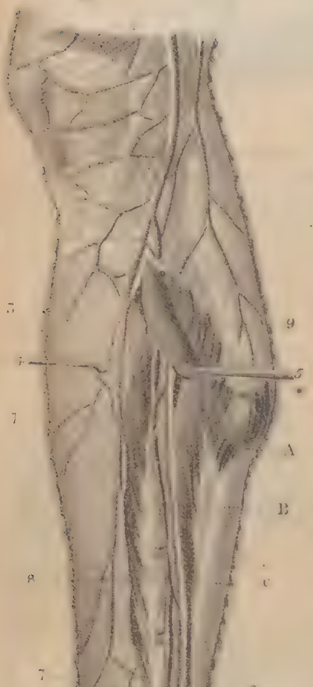


FIG. 2

Plate 18.

Fig. 1.—Relations of the posterior tibial artery, *A*, lying between the superficial and deep layers of muscles upon the back of the leg, covered in the upper half of its course by 9, the gastroenemius and soleus muscles, and lying upon 8, the common flexor of the toes. In the lower part of the leg the posterior tibial artery lies between 6, the tendo achillis, and 7, the common flexor of the toes, which separate the vessel from the face of the tibia; *C*, the posterior tibial nerve which follows the course of the artery; *B*, the tibial veins, two of which accompany the vessel.

Fig. 2.—The position of incisions for exposing the posterior tibial artery in its upper, middle, or lower third, in a line drawn from the inner and posterior edge of the head of the tibia to a point midway between the tendo achillis and inner malleolus: 3, an incision through the skin; *b*, the superficial fascia; *d*, the inner border of the soleus muscle, separated from its attachment to the tibia and drawn outward; *A*, the posterior tibial artery, accompanied by two veins, and having the posterior tibial nerve in its immediate neighborhood.

Plate 19.

Fig. 1.—The relations of the iliac arteries, passing through the upper edge of the pelvic cavity to be continuous, as femoral artery, upon the thigh. 1, portion of abdominal walls; 2, anterior superior spinous process of the ilium; 3, sartorius muscle; 4, psoas magnus muscle; 5, iliacus internus muscle, upon the lower portion of which, as a bed, lies the iliac vessels and nerves; *A*, inferior portion of the aorta bifurcating into *E*, common iliac artery, which in turn bifurcates, after a course of two and a half inches, into *D*, the internal, and *H*, the external iliac arteries. Just before reaching Poupart's ligament the external iliac artey gives off two branches—*c*, epigastric artery, and *e*, the circumflex ilii; *G*, anterior plexus of femoral nerves lying upon the outer side of the artery; *F*, the common iliac vein, passing under the iliac artery to take up a position upon its inner side; *K*, spermatic cord, with testicle appended.

Fig. 2.—Continuation of fig. 1, showing the course of the femoral artèry *A*, through the thigh, accompanied by *C*, the femoral vein, and *F*, the internal cutaneous nerves; one of these, in immediate juxtaposition with the femoral vessels, passes under the tendinous bridge, 2, in the adductor magnus muscle—the other runs over the bridge, to become subcutaneous and supply the skin on the inner and anterior face of the leg and foot; the sartorious muscle is drawn upward and outward, so as to expose the femoral vessel running under it; *d*, the saphenous vein, emptying into the femoral vein, through the saphenous opening in the fascia lata, and on a level with the origin of the profunda femoris artery; 1, Poupart's ligament, forming the base of Scarpa's triangle.

Fig. 3 traces the course of the femoral artery, and the direction of incisions necessary for exposing it in any part of its course. These incisions will be found in a line drawn from the middle of Poupart's ligament to the inner and posterior edge of the inner condyle of the femur. The three incisions upon the thigh lie in such a line; on the groin, the incision is at right angles to the course of the artery: *a*, incision in skin; *b*, superficial fascia; *c*, sheath of the vessels; *d*, femoral vein on inner side of artery; *A*, femoral artery, raised upon the grooved director.

FIG. 1.

FIG. 2.

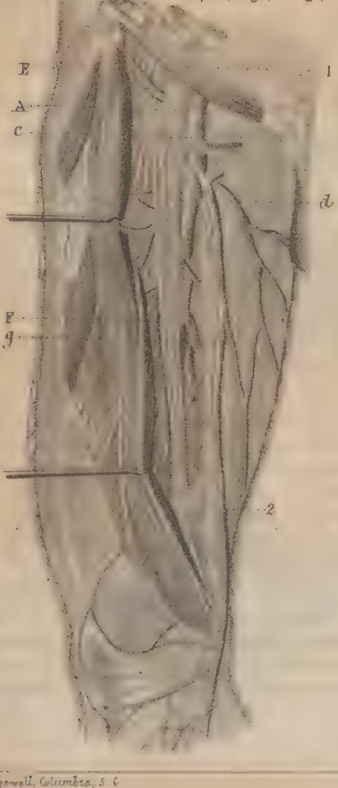
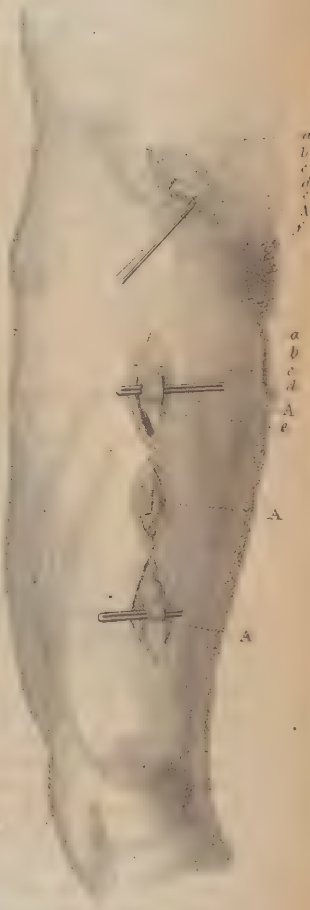


FIG. 3.



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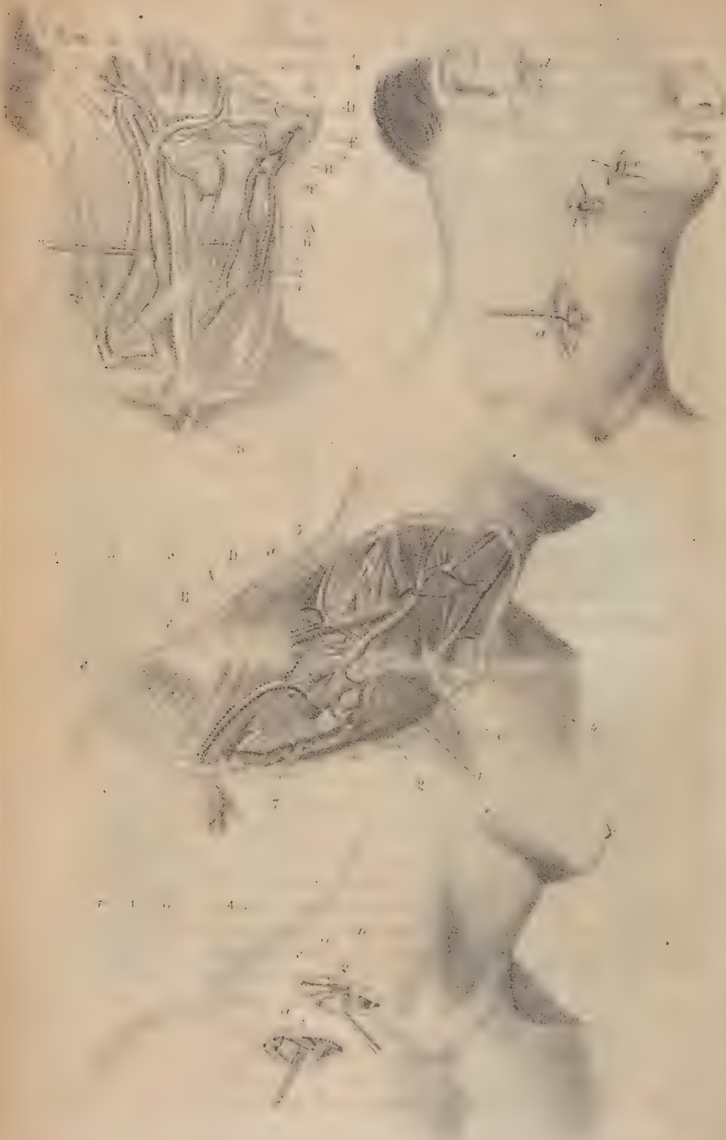

Plate 20.

Fig. 1.—Anatomy of the neck. 1, the sterno-hyoid and thyroid muscles, covering the trachea; 2, the omo-hyoid muscle, running obliquely across the neck from the scapula to the hyoid bone, and forming two triangles of the deep cervical region—the superior and inferior cervical triangles; 3, the sterno-cleido-mastoid muscle, severed in its lower third—a portion drawn over the clavicle, the upper portion drawn aside by a hook, in order to expose the deep region of the neck which is covered in by this muscle; 4, the masseter muscle, attached to the lower jaw: *A*, common carotid artery, deeply seated below where covered by the clavicle and sterno-cleido-mastoid muscle, and becoming more superficial after passing beneath the omo-hyoid muscle. This artery bifurcates on a level with the upper border of the thyroid cartilage into internal and external carotid, the external branch coursing upward in front of the ear; *B*, the internal jugular vein, running along the outer and posterior surface of the artery, and being much larger than the carotid vessel, it covers it when distended with blood; *C*, pneumogastric nerve, running in the sheath of the vessels between and behind them; *D*, bifurcation of the internal jugular vein, with branches corresponding to the bifurcations of the carotid vessel; *E*, facial vessels; *F*, superior thyroid artery, the first branch from the external carotid; *H*, lingual artery.

Fig. 2 represents course of the common carotid and some of the branches of the external carotid artery. *a*, incision for ligating the common carotid artery in the middle of the neck; *b*, incision for exposing the lingual artery; *c*, incision exposing the facial artery as it runs over the lower jaw, immediately in front of the insertion of the masseter muscle; *d*, ligation of the temporal artery or terminal branch of the external carotid, in front of the ear.

Fig. 3.—Anatomy of the lower portion of the neck and upper portion of the chest. 1, the clavicle; 2, the great pectoral muscle attached to the clavicle; 4, stern-cleido-mastoid muscle; 6. deltoid muscle; 7, coranoid portion of the pectoralis minor; *A*, subclavian artery, arching through the subclavicular region, to be continuous as axillary; *B*, axillary vein, continuous as subclavian, lying upon the inferior and outer side of the artery, and receiving the cephalic vein, *C*, from the arm; *D*, brachial plexus of nerves running behind and posterior to the artery; *a*, scapular branch of the subclavian artery, running across the root of the neck; *e*, inferior thyroid artery, ascending from the subclavian.

Fig. 4.—The two incisions required in exposing the subclavian and axillary arteries. 2, incision four inches long, parallel with and just above the clavicle; *a*, subclavian artery; *b*, the subclavian vein on inner side of vessel; *c*, the brachial plexus of nerves on outer side of artery; 1, incision below and parallel with the clavicle for exposing the axillary artery; *a*, artery; *b*, axillary vein upon its inner and anterior side.

Plate 21.

Fig. 1.—Anatomy of the head. The scalp and skull removed from the outer half of the head, exposing the brain enveloped in its meninges—the thickness of the scalp and skull is distinctly seen; *b b b* is the prolongation of the dura mater, called the falx cerebri, between the folds of which is contained the superior longitudinal sinus; *C D*, large lateral sinus of the brain which, upon its exit from the skull at the foramen lascerum posterius, forms the origin of the internal jugular; *a a a*, branches of the arteria meningia media, ramifying over the surface of the brain, being partially lodged in grooves in the inner face of the temporal bone.

Fig. 2 shows the application of the trephine in depressed fractures of the skull. *a a a a*, the four corners of the crucial flap dissected up and turned out so as to expose the skull. The crown of the trephine is applied to the bone, and the hand of the operator grasps the handle in such a way as to permit of rotation, while the index finger steadies the instrument.

Fig. 3.—A fracture of the skull, with isolated fragment. A four-sided flap has been dissected up so as to expose the injury, and the loose fragment has been seized by a strong forceps, and is being extracted.

Fig. 4 shows the stellated fracture produced by a concentration of the force causing the injury. A small portion of the bone has been removed to facilitate the application of the lever, so as to elevate the depressed fragments and restore them to their proper position.

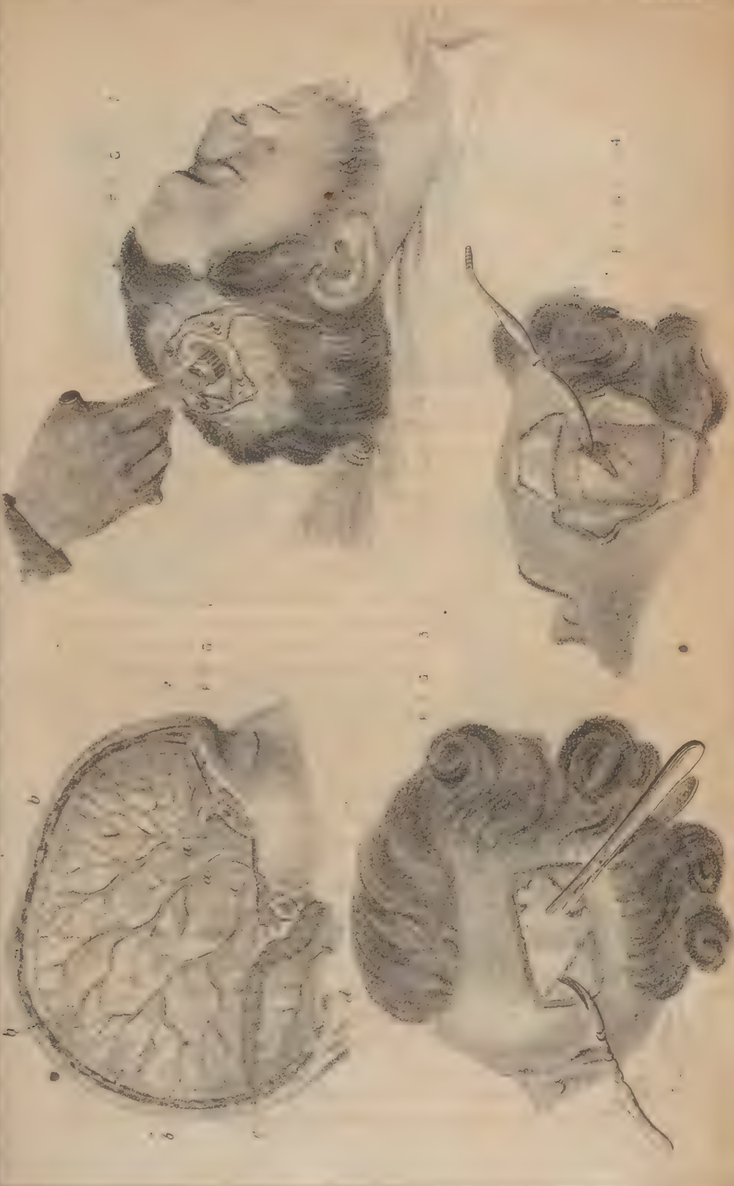

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FIG. 2
FIG. 1
FIG. 3
FIG. 4
FIG. 5
FIG. 6
FIG. 7

Plate 22.

Fig. 1 represents the manner of holding the scrotum in operating for hydrocele, so as to make the sac tense by forcing all the serum to the most dependent portion of the scrotal sac. As the testicle is adherent to the back of the sac, the forcing of the fluid in front throws a thick layer of serum in front of the testicle, shielding it from injury when the sac is punctured by the trocar. This figure also shows how the trocar should be held by the surgeon.

The following plates show the various methods used in obliterating the enlarged veins in the disease called varicocele:

Fig. 2.—Incision over the spermatic cord at the junction of the scrotum with the groin, and isolation of the spermatic artery for ligation in varicocele. The incision extends through the skin, cellular tissue, superficial fascia, and proper fascia of the cord, separating the elements of the spermatic cord and permitting the spermatic artery to be secured.

Fig. 3 shows the operation of applying a ligature to the spermatic vessels subcutaneously. *c*, scrotum; *b*, enlarged cord, under which a double thread has been passed, leaving out the noose, *a*.

Fig. 4 shows the subcutaneous application of a double ligature. One double thread passes under the other over the cord, the ends of one passing respectively through the noose of the other, so that, when firm traction is made, as in fig. 5, all the vessels are compressed, and will be finally obliterated. In fig. 4 the vas deferens, *b*, or spermatic tube from the testicle, is not included in the ligature.

Fig. 6 exhibits the enlarged convoluted condition of the spermatic veins in varicocele. A pin, *a*, has been passed behind these enlarged vessels, *b*.

Fig. 7 shows the position of the pin, *a*, transfixing the scrotum, with *b b*, a strong thread wound tightly in figure of 8 around the pin, and compressing the vessels between the pin and the thread.

Plate 23.

Fistula in ano, with method of operating for obtaining a radical cure.

Fig. 1 exhibits the appearances of internal incomplete fistula. *r*, rectum ; *f*, fistulous sac in the surrounding cellular tissue, with an orifice discharging the secretion of the fistula into the bowel, above the sphincter muscle.

Fig. 2 indicates an incomplete external fistula. *r*, cavity of rectum ; *b*, the irregular sac of a chronic abscess, located in the loose cellular tissue around the rectum, having an external orifice, *a*, from which a thin discharge daily escapes. Although the fundus of this sac lies in juxtaposition with the bowel, and may be separated from it only by the thickness of the mucus membrane, it has no communication with the bowel.

Fig. 3 shows how a complete fistula in ano has an orifice, *a*, communicating with the cavity of the bowel, by which pus or the secretion from the fistula is not only thrown into the bowel to escape by stool, but gases. and even fecal matter, can escape by it and through the fistula, to appear at *b*, the outer orifice or exit upon the buttock.

Fig. 4 shows how the silver flexible probe is passed into the bowel during the operation for fistula in ano. *r*, cavity of rectum, with the index finger of the left hand of the surgeon passed up into it : *n*, a silver probe entered at *b*, the outer orifice, and passed along the fistula through *a*, the inner orifice, until it is forced well into the bowel, when readily felt by the finger; *s*, the interval of tissue to be divided by the knife, which lies between the probe and the finger.

Fig. 5.—The parts as above. The finger has been hooked over the end of the probe, and has drawn the bulb out of the anus and lodged it upon the opposite buttock. A sharp-pointed bistoury, *c*, is now run into the groove of the probe in order to divide *s*, the intervening tissue containing the sphincter muscle, which is the important structure requiring division.

Fig. 6.—The position of the patient during the operation for fistula in ano. The hand of an assistant separates the buttock, and exposes perfectly the fistula, with the anus : the surgeon either passes the probe as in fig. 5, and cuts upon it, or passes the index finger of the left hand in the anus, and pushing a probe-pointed bistoury through the fistula into the bowel, keeps his finger upon the extremity of the blade, while he makes it cut through the intervening septum.

FIG 1

FIG 2

FIG 3

FIG 4

FIG 5

FIG 6

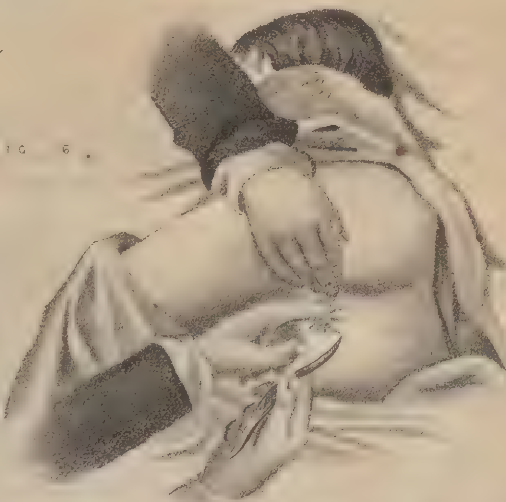

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FIG. 1.

FIGS. 6. 7.

FIG. 2.

FIG. 3.

Mode of making extension with adhesive plaster

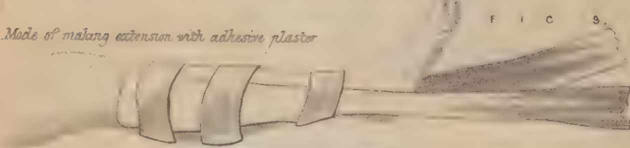


FIG. 4.

FIG. 5.

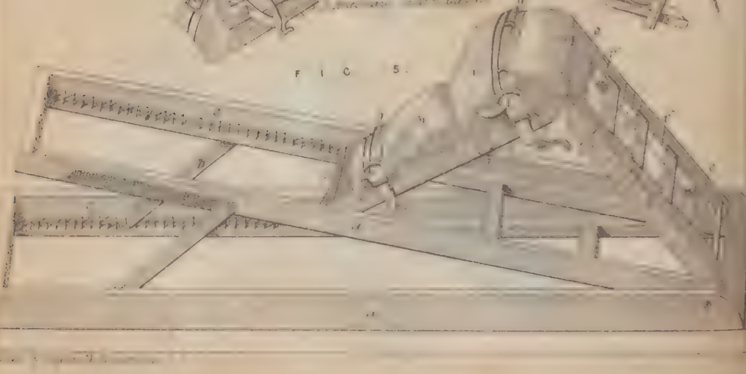


Plate 24.

Fig. 1.—An angular splint for the arm, with screw for flexing and extending the splint—an excellent form of splint for straightening contracted limbs, or stiffened elbow-joints.

Fig. 2.—A straight splint for treating fractures of the inferior extremity. 1, 2. bands of adhesive plaster applied around the upper part of thigh, and secured in position by 3, a circular band of adhesive plaster; counter-extension is made by means of these strips; 4, broad strips of adhesive plaster, to be attached to each side of the leg from the foot to the knee, and tied under the foot; 5, the screw, for drawing the leg downward, and making extension by traction upon the adhesive bands.

Fig. 3 shows more satisfactorily how the adhesive plaster is applied for making extension in fractures—two broad strips attached to the inner and outer face of the leg, and secured by two or three circular bands.

Fig. 4.—Amesbury's splint, or inclined plane, for treating fractures of the leg or thigh, showing also the mode of application. By means of the screw behind the knee, which flexes or extends the splint, the apparatus becomes very useful in correcting deformities from contracted limbs.

Fig. 5.—An excellent form of double inclined plane for treating all cases of fracture of the lower extremity.

Fig. 6.—Two simple forms of wooden stumps to be worn after amputation of the inferior extremity.

Plate 25.

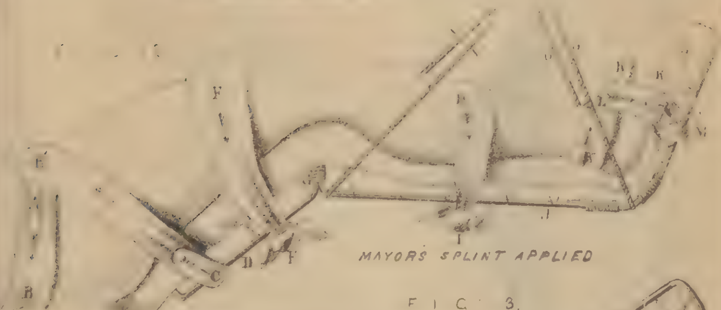
Fig. 3.—Posterior wire splint of Mayor. *M*, foot-piece; *J*, support for the leg; *D*, for thigh; *C*, the joint behind the knee. This splint is made of stout wire, with a fine wire passed from side to side, forming an open platform for supporting the limb.

Fig. 2.—The application of Mayor's posterior wire splint, secured to the limb by bands or soft handkerchiefs, folded in form of cravat. One passing around the ankle, *K L M*, secures the foot to the foot-piece of the splint: one, *H I*, attaches the leg firmly to the wire: the handkerchief, *E*, secures the thigh firmly to the splint, while *B B C* passes around the loins and attaches the upper portion of the apparatus to the trunk—a very necessary band for the comfort of the patient and the successful treatment of the case. *N N*, *O O*, the two suspending cords which, uniting in one, allows the limb to be suspended from the ceiling or top of the bedstead. The advantage of this splint is its easy and rapid application, giving but little pain, as it requires but little manipulation of the fractured limb. It also exposes the entire surface for inspection, or any wound for treatment, while at the same time it gives a steady support to the entire member.

Fig. 1.—The application of Mayor's posterior wire splint to a fracture of the leg, permitting the patient to get out of bed, and to amuse himself in many ways, without suffering pain or interfering with the progress of the cure.

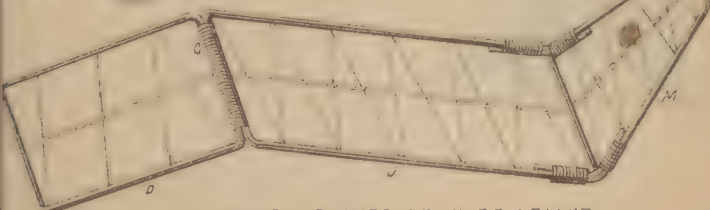
FIG. 1.

FIG. 2.



MAYORS SPLINT APPLIED

FIG. 3.



MAYORS POSTERIOR WIRE SPLINT.

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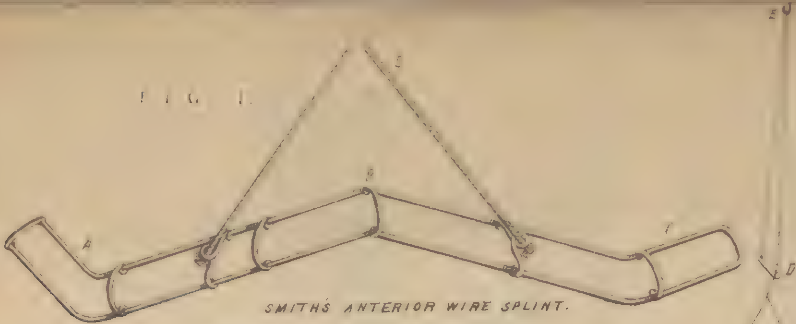
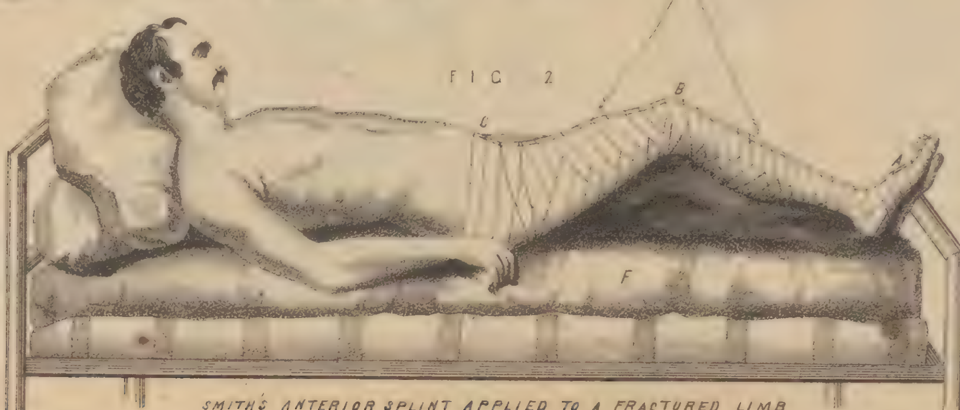
FIG. 1.



SMITH'S ANTERIOR WIRE SPLINT.

FIG. 2



SMITH'S ANTERIOR SPLINT APPLIED TO A FRACTURED LIMB

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Plate 26.

Fig. 1.—Smith's anterior wire splint, long enough to reach from the extremity of the big toes to the umbilicus. The splint must be bent to adapt itself to the sound limb, the angles, *A B C*, corresponding respectively to the bend of the ankle, knee, and groin. When applied to the fractured limb, the length of splint between the angles will, when closely bandaged, make sufficient traction to elongate the limb and remove deformity from shortening. Transverse pieces of stout wire strengthen the splint. In its application these must not be allowed to rest immediately upon the ankle, knee, or groin, but should be so knocked aside as to avoid painful pressure upon these points. *D* is a cord by which the limb and splint are suspended: the two hooks by which the cord is connected to the splint can be moved upon the horizontal wires for proper adjustment.

Fig. 2.—Smith's anterior wire splint applied. *A B C*, the angles of the splint as in fig. 1, moulded from the sound limb: *E*, hook in the ceiling, with suspending cord passing over it, and secured by a wooden block, *D*. By sliding this block upon the cord, *D E*, the limb can be elevated or depressed. As it is only necessary to swing the limb clear of the bed, in the figure the heel is not elevated more than two inches from the mattress, *F*. In its application, the splint is first bandaged; several folds of thick, soft cloth are then placed upon the anterior surface of the limb, from the toes to a level with the false ribs, to protect the parts from painful pressure: the splint is then laid on, attached by short pieces of bandage to the foot, knee, and thigh, and then more intimately secured by a roll of bandage snugly applied from the toes to the abdomen, as seen in fig 2: a spica or figure of 8 bandage around the groin and abdomen, secures the upper portion of the splint to the trunk, and consolidates the apparatus. When the injury treated is a compound fracture, the bandage should be omitted at the wound; stop below it, and recommence with a new band above it. If the thigh be fractured, let the suspending cord run obliquely to the ceiling, so as to exercise traction on the fractured limb.

A METHOD OF HEALING RAPIDLY GUN-SHOT WOUNDS.

It is a familiar fact to hospital surgeons, that where balls course for some distance through the tissues, these long tracks often heal without suppuration, leaving only two disk-like, raw surfaces, which heal with very little discharge.

The rapid closure of these tracks is particularly observed in wounds so situated that the walls of the track are kept in constant apposition at one or more points, thus excluding air. The crushed tissues along these tracks may slough, but it is a molicular disintegration, solution, and absorption, simulating the disappearance of extensive extravasation of blood, or the extensive subcutaneous bruising from shell-wounds, where the skin is not broken. In such cases of rapid healing we never find that excessive deposit of lymph, glueing together muscles and interfering, for a long time after cicatrization, with the uses of the limb. Led by this experience, I would suggest to the Medical Staff of the army a simple method of rapidly curing gun-shot wounds, which promises the most valuable results. It consists in converting all gun-shot wounds into subcutaneous injuries. Immediately after the injury has been received, when all foreign bodies have been removed, including fragments of bone, and when hemorrhage has been checked, but long before any reaction has been established, make two eliptical incisions, extending only through the thickness of the skin, and enclosing the wound with its immediate surroundings of crushed tissues. Dissect up this eliptical flap of skin from the muscles, and two clean incisions are substituted for the ragged wound. If these incisions are carefully brought together by sutures, and the limb or trunk be supported by a roll of bandage, they will rapidly unite by the first intention, converting the track, however long it may be, into a subcutaneous wound, which will heal rapidly without suppuration, by a process known as the remodelling process, which is well exemplified in the subcutaneous division of tendons.

As the resection of the wounds extends solely through the skin, the operation is trifling, adding nothing to the serious character of the injury, should the incisions not heal by the first intention. Should quick union be obtained, comparatively speaking, a cure is effected in from forty-eight to seventy-two hours, which, under the usual conditions, will require weeks, and may not be cured for months; the patient escaping all of the dangers from hospital gangrene, secondary hemorrhage, and the common one of protracted suppuration, followed often by contracted limbs; and, besides a large saving of human life, the government saving in hospital accommodation, in supplies for the wounded, in the avoidance of long and frequently repeated furloughs, and in the speedy restoration of the wounded, to add to the effective strength of the army in the field. Nearly the entire treatment of the wounded should be perfected at the field infirmaries. In the few days following a battle, while the wounded are awaiting transportation, the outer orifices of their wounds can be healed, and the cases, now being beyond all danger, could be directly furloughed for a short period, without going into hospital.

The chief objection raised by the inexperienced, viz., that the skin will not unite over an excavated track, is confuted by the every day occurrence familiar to field-surgeons, viz., that when a ball traverses a limb, remaining under the skin on the opposite side to the orifice of entrance, the incision to remove the ball will heal up at once, if any care be taken to keep the lips of the incision in apposition, although the track of the ball leads directly to the incision.